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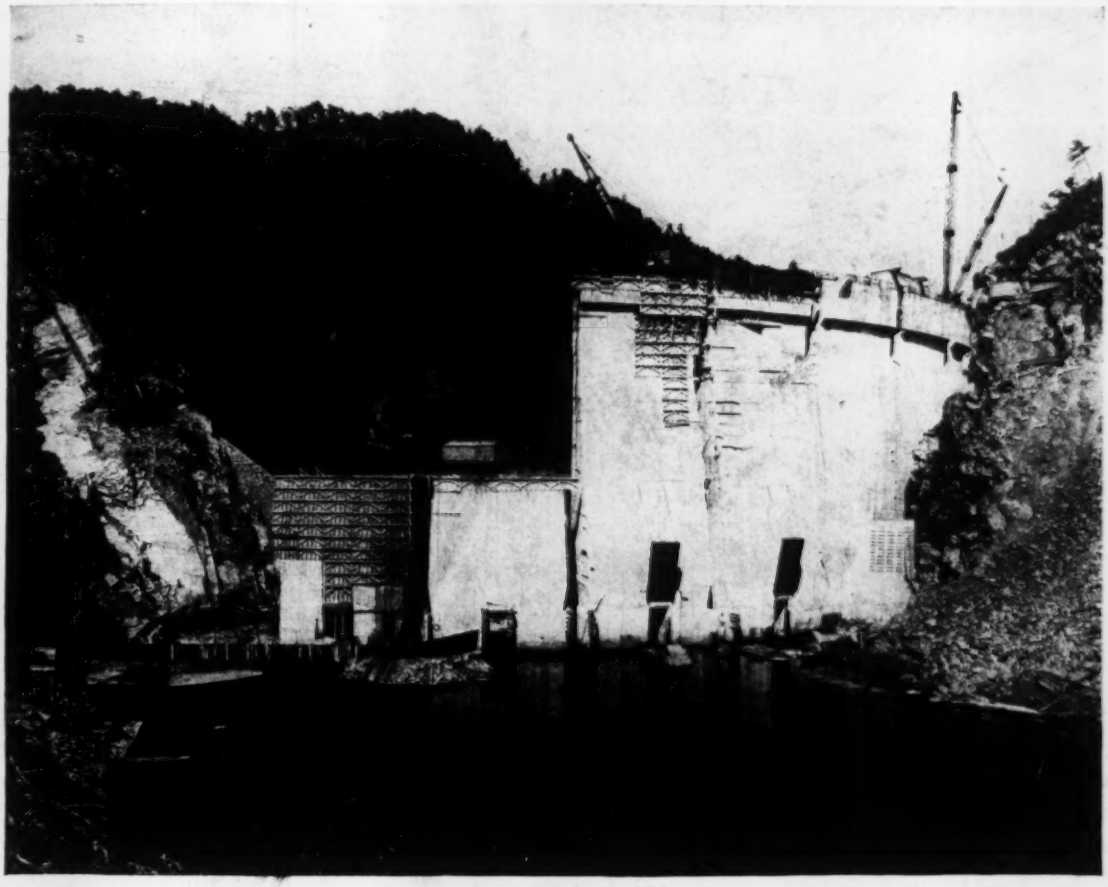

High Arch Dam on the Big Pigeon River in North Carolina

Design and Construction of the Waterville Dam

Repairs of Breaks in the Outlet Tunnel Through a Rock-Fill Dam

Setting Temperatures of Concrete in Large Bridge Piers

Softening Water with Zeolite at Magnum, Okla.

Behavior of Timber Framing Under Stress

Abstract of a Report on the Regional Plan of New York and Its Environs

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Contents

Volume 102, Number 23, June 6, 1929

Design and Construction of the Waterville Dam 894
THIN arch dam of overflow type built high up in mountains of North Carolina.

Behavior of Timber Structural Framing Under Stress 898
ECCENTRIC location of upper story columns make it difficult to insure continuity. By S. E. Berkenblit

Zeolite Water-Softening Plant at Magnum, Okla. 900
OPEN BASINS used instead of pressure tanks. Hardness of water reduced to three grains per gallon. By H. B. Crane

Repair of Breaks in Outlet Tunnel of Rock-Fill Dam 904
ROCK POCKETS behind lining of outlet tunnel walls result in failure of part of lining. By Fred H. Tibbetts

Regional Plan for Area with Twenty Million Population 907
GRAPHICAL presentation of 7-year study of the needs of the region around New York City.

Setting Temperatures of Concrete in Bridge Piers 913
TESTS of heat changes in concrete and in inclosure show setting temperatures fluctuating with outside cold. By A. A. Jakkula

Mechanical Equipment of Office and Newspaper Building 914
DAILY NEWS Building over Chicago Union Station equipped for ventilation of tracks and newspaper service.

Failure of Hackensack River Bascule Bridge 916
FINAL report of board of engineers gives failure of counterweight tower leg due to inadequate design as cause.

Editorial 891

Letters to the Editor 918

News of the Week 919

Construction Equipment and Materials 925

Business Side of Contruction 927

Current Prices of Construction Materials 930

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Volume 102 NEW YORK, JUNE 6, 1929 Number 23

Again the Economic Balance

WHEN the newspapers report losses of value amounting to some billions of dollars in stock-market declines, one inevitably asks whether this is real money and whether it has any relation to business welfare, especially as the momentum of industry has not shown a check. No evidence has appeared to show that such shifts of "value" affect either productive power or the needs of consumption, and still less, we believe, are they related to working efficiency. These, however, are the material factors of national prosperity, as they were lately outlined by the report on Recent Economic Changes. Superimposed upon them as secondary factors are *first*, fair economic balance as between different units of the producer-consumer circle, and *second*, the elusive combination of credit and confidence. If the present efforts toward stabilization of agricultural prices succeed, and if throttling of business credits is halted in time, neither of the secondary factors seems capable of giving rise to any disturbance, even though more impressive paper shrinkages of value should occur.

Covering the Country

THE spreading movement of recent years to carry the work of technical societies more extensively through the land by rotating their meetings as broadly as possible between north and south, east and west, still continues to spread. It is a constructive movement. It expresses the drift away from the old idea of a society as something rooted to one chosen spot, and toward the newer view of the society as being a moving organism, living of and for its membership from coast to coast. Most recent of the organizations to become thus peripatetic is the American Road Builders Association, long acclimated in Chicago and Cleveland but now embarked on a series of moves which is to take it south and west in rotation after its next meeting at Atlantic City. Its travels over the country will benefit the road thinking of many regions, we believe, and at the same time will exert an invigorating influence on the association itself, a gain not to be overlooked. There are a few societies of more strictly technical character that have not yet come to recognize the broadening value of travel. But the future is likely to make the habit universal.

Subgrade Lessons

A NOTABLE contribution to the literature of highway engineering has been made in the report in *Public Roads* on road foundations by C. A. Hogentogler and Charles Terzaghi of the Bureau of Public Roads. In this report, which will occupy some 60 pages of book print, the investigators summarize the present knowledge on soils and subgrades as these are involved in the design of road surfaces. The argument and conclusions are too many for summary. Indeed the report has to be comprehended as a whole before any recital of the conclusions has significance. The great lesson is the paramount importance of foundation subsoils and their reasonably simple classification into groups despite the multifarious conditions and kinds of soil encountered in a nationwide road system. This simplification by classification is a notable accomplishment toward clarifying a discussion which is easily befogged by the intrusion of multitudinous details of soils, moisture and temperature. Specifically the report furnishes the roadbuilder with the latest working knowledge of subgrade reactions under pavement, subgrade surface and incorporated treatments, base-course materials, drainage and surface slab design. In general it is of wider value in bringing the conviction that soil analyses and subsoil profiles disclosed by subgrade surveys break down into simple practicalities.

Demonstration and Experiment

THAT interesting modern industrial activity, public education in the problems and possibilities of an industry, finds one of its most picturesque developments in the exhibits of lighting which have been established by two large electric manufacturers. They constitute not only full-scale demonstrations of requirements and methods of illumination but also serve as public laboratories where interested persons may put to test various arrangements of lighting to provide the sought-for illumination. One such "lighting institute" was provided at Harrison, N. J., a year or more ago; a second, even more elaborate, was inaugurated in New York last week. Their ideal objective is to stimulate public appreciation of proper illumination so that the practice of lighting may be raised to a level where it will increase human efficiency by improved visibility and add to the general wellbeing by reduced eye irritation. Doubtless this result will be attained only in part; but however much or little is accomplished in this direction, these centers of illumination knowledge should have quite as important a reaction on illumination men themselves. As has been said in these columns before now, illumination engineering as exemplified in lighting practice has accomplished much less than might fairly be expected in the way of skillful application of the excellent light sources which the modern art makes available. They still supply to the eye of reader, of promenader, of desk worker and of automobile driver more glare than useful light. Better days will come when light users and lighting experts make progress together—the former by learning how to demand better light, the latter by training themselves to supply it.

Outlet Control

DIFFICULTIES with the outlet tunnel of North Bowman dam in California, described in this issue, again draw attention to the need for control gates at the intake end of pressure tunnels through earth or rock-fill dams. The near-failure of the Greenville dam in North Carolina last year was a still more striking example of

the risk involved in not providing means for shutting off the flow of water or of relieving hydrostatic pressure on conduits or tunnels passing under such structures. Where no control valve is provided at the intake of the conduit the only way to repair leaks which may develop within the structure and endanger its stability is by emptying the reservoir, an expensive operation and always far too slow to avert an accident when leakage once begins. At North Bowman dam, unfilled rock pockets behind the concrete lining of the tunnel were the source of the trouble; though the cause is unique it is no less serious than the more common one of rupture due to slight settlement or other movements of the fill. Headgates afford protection in either case, and must therefore be classed as indispensable elements of safety in such dams, despite their cost. Entrance control for pressure conduits through earth or rock-fill dams generally have taken the form of towers, but less costly means are available. At North Bowman dam the control gate installed during the repair work is a roller gate which may be run down the upstream face of the dam when required, similar to that used at the Waeggital power plant in Switzerland, as described in *Engineering News-Record* of July 14, 1927, p. 60; where the water depth is great such a gate operated on an inclined track need not, as in the case of a tower, add greatly to the total cost of the structure. Insurance against trouble from leaks in pressure conduits is essential in any event.

A Great Regional Plan

EVERYONE knows that our cities are growing rapidly. Few visualize what that growth means in terms of wants to be supplied and the accompanying problems in engineering, finance and administration. Fewer still have any conception of the fact that during the past two decades many and great forces, both centrifugal and centripetal, have extended municipal problems beyond the boundaries of single cities to include not only suburbs but also more remote urban areas, together with the rural intervening spaces. Thus have regional areas and ways to meet their needs been added to the problems long confined to single cities, and thus is there a new and larger demand for the engineer—for the city and regional growth problems are ubiquitous.

The magnitude of the Regional Plan of New York and Environs is forcibly shown by one figure alone: 20,000,000 people are anticipated within the region in 1965. Already the population in 436 cities, villages and towns of the region is some 10,000,000, of which about 6,000,000 are in New York City. This 6,000,000 is almost 1,000,000 in excess of the total population of the 141 places of 8,000 or more in the United States just before the outbreak of the Civil War in 1860. The 20,000,000 estimate for 1865 may be compared with 18,250,000 in 445 cities of the same rank as lately as 1890; or with the 17,000,000 population of the whole United States in 1840. Considering the growth of human needs since those earlier dates and the means now commonly provided to meet them, the magnitude of the problem of planning for the New York Region becomes still more impressive.

The portion of the Graphic Plan of the New York Region thus far made public discloses the concentrated results of many years of study of ways and means of transportation—by land, water and air. These are tied in with one of the great fundamentals of any such study, distribution of population and allocation of land for residence, industrial and business uses and open spaces. Wisely, the regional planners attempted nothing hard and fast as to either land uses or suburban rapid transit, trunk-line railways, waterways, parkways and boulevards or airports; but just as obviously, all these things are interdependent and must be correlated unless they are to be left, as in the past, to grow in hurly burly fashion. Even though in any planning much must be left to future readjustment, a plan to work to is a vital basis of sound development. Considered in this light as an attempt to correlate the probable future distribution of population, of land uses and of communication routes, not forgetting recreation and various amenities, the Regional Plan of New York and its Environs deserves high commendation.

It should be recalled that the region in question is distributed in three states, 22 counties and 431 cities and towns. For this reason alone the problem of carrying out the plan is unparalleled in magnitude and difficulties. Besides the obstacles resulting from so many and so diversified governmental units there are the obstacles inherent in the multitude of private interests involved. Co-operation under able and disinterested leadership is the only hope for carrying out more than small fragments of the plan. This means that governments and civic organizations on the one hand, and utilities and commercial interests on the other hand, must work in joint effort, with the assistance of intelligent public opinion.

Leadership to promote co-operation among so many interests must come from some private but thoroughly representative organization. The Chicago plan, likewise created privately, but with a broad basis of civic organization support, has owed its successful execution very largely to a broadly representative commission. Following in the same course, the Regional Plan Association of New York already has been incorporated to lead the way to the execution of the New York regional plan.

New York and its environs do not stand along in the need for regional planning—a fact attested by perhaps two score county or regional plan associations and two or three governmental organizations of like scope. This is an age of city and regional growth. Associated problems will continue in ever-increasing magnitude, diversity and complexity. They entail great questions in finance, government and engineering. Among the professions that must contribute to their solution the engineer is outstanding in experience. He should seize the opportunity for great public service held out by the needs of the day and the coming years.

Structural Dynamics

FULLY confirming early impressions of the Hackensack River bascule bridge collapse last December, the final report of the investigating board traces the collapse to the fatal weakness of an essential structural element, the counterweight tower. It also reveals the fact that this weakness was due to a startling failure to consider the bridge as a machine rather than as a merely static structure. The extraordinary stress conditions which the report discloses place such emphasis on this latter feature as to promise that the subject of structural dynamics will occupy a position of marked importance in the future development of bridge engineering. A brief discussion of the accident under the heading "Ma-

chine Stresses," in our issue of Jan. 10, p. 52, pointed out the necessity of giving consideration to the phenomena of motions in structures; the details given in the present report set off this view in sharp relief.

It is clear from the figures cited by the investigators that directly applied forces, whether of wind, motor torque or brakes, constitute only part of the actions which a bridge structure of this kind must resist, and perhaps not the most significant part. Inertia forces may be quite as great. Further, the forces developed in resonant vibrations arising from lack of rigidity may become critical. In the Hackensack bridge the stresses chargeable to oscillatory deflections were almost as large as all other stresses put together. Unless all such actions are duly provided for in the construction, claims of adequate strength are only a delusion.

It is well to keep in mind that movable bridges constitute a higher type of structure than those dealt with in the conventional engineering of fixed bridges. Even the complications arising from elastic constraint (in bridges of statically indeterminate character) are not entitled to more studious analysis than those caused by dynamic actions. But it should be remembered that dynamic effects are to be looked for not only in movable bridges, but also in various other structures which involve motion, and may also appear in building frames where height and dimensions give rise to the possibility of resonant vibration. Further, even ordinary bridges may experience dynamic stresses from their traveling loads and from the vibrations which give rise to the so-called "impact" stresses.

To what extent any or all of these dynamic actions can be accounted for through empirical allowances (as is customary in case of impact) or may be considered to be covered by the reserve strength of the material, is obviously not capable of a general answer but depends on study of the particular structure or class of structures involved. For the case of movable bridges similar to the one involved in the Hackensack accident, the expedient of an arbitrary allowance as represented in the Canadian specification requirements falls short of the needs of the case, as the figures make evident.

It is mere speculation, in a measure, to attempt to discuss the origin of the disturbances which set up and maintained the large oscillations of the tower which were noted by the investigating board. In part, however, they probably arose through irregular variations of friction at the large counterweight trunnions, for slowly moving bearings present difficulty in maintaining a continuous film of lubricant. If this is the case, there is no certainty whether greater rigidity of the tower would reduce the vibration stresses, since the development of resonant vibrations depends on the chance coincidence of period between the counterweight system and the bearing chatter. The more important, therefore, that bearing design be studied with great care.

The work of the investigating board has furnished a document that promises to hold a place of importance in the data of bridge engineering for many years. It derives its weight not only from the remarkable nature of the failure—the sudden collapse of a new and apparently strong and dependable bascule bridge—but as well from the searching tests and studies which the investigators applied to the problems set before them. The members of the board and the New Jersey Highway Department which appointed them are entitled to the thanks of the profession for the service which they have rendered the art of bridge engineering.

Gasoline Tax Dangers

A PORTENTOUS situation is arising in gasoline tax legislation. There is growing conviction that it is becoming inequitable. Indeed unless the decided trends manifested in the enactments of the legislative year now closing are altered gasoline taxes may be expected to provoke opposition and evasion instead of the present generous approval and observance. This would be calamitous.

The tax on gasoline is a source of income vital to road improvement. It has been successful because of the low cost of collection, the diffusion of the tax burden and the objective of the impost. The tax bearer has as a rule been more in favor of better roads than he is opposed to the collection of the tax. He is not likely to remain in this disposition longer than he is certain of the use of the tax funds for better roads and is unimpressed with their disproportion to the value of the commodity. His reaction is likely to be violent in case of any excursion beyond these convictions by legislation—and there is a tendency in current legislation to take this departure.

Last winter's sessions of state legislatures caused exactly a third of the 48 states to raise their gas tax rates, and the two states that remained without a tax established one. In virtually every other legislature there were bills providing for changes in rates or in methods of distribution, or for diversion of funds to other uses than road improvement. This latter demand will not decrease as the amount of money derived from the gasoline tax increases with higher rates and more general use of motor vehicles.

Virtually an orgy in gasoline tax rate raising prevailed. Thirteen states increased their tax rate 1c. a gallon and three states increased it 2c. a gallon. With these increases the average gasoline tax rate of the 48 states is 3c., which is higher than the highest rate in any state four years ago. Now the highest rate is 6c. This rate and the 5c. rates in several other states approach an unreasonable sales charge. Yet this is not the most serious matter.

Diversion of funds has a far graver aspect. Except for the half-dozen states which, in their original acts establishing the gasoline tax, allotted a part of the income to other uses than road improvement, few gasoline tax diversion proposals have become law, but every year bills are being more urgently pressed providing for allotments to the general tax fund, to schools and to park systems. This is a perversion of taxation logic. At present gas taxes except in a few states are paid only by those who use gasoline in traveling the highways. The conviction is natural that their tax money belongs therefore to the highways. On this conviction diversion will be challenged and the gasoline tax resisted as unjustifiable special legislation. It already has powerful critics on this score.

The gasoline tax in a period of ten years has taken the country by storm. The people today are cheerfully paying gas taxes to the amount of some $350,000,000 annually. They are submitting to sales charges which would be endured on almost no other commodity of universal use. It is not the part of wisdom of those who have the interest of highway development at heart to multiply exactions until opposition and evasion are encouraged. The highway engineer has an important duty to perform in curbing gas tax legislation. His first and strongest fight must be against diversion from highway uses to extraneous services, however worthy.

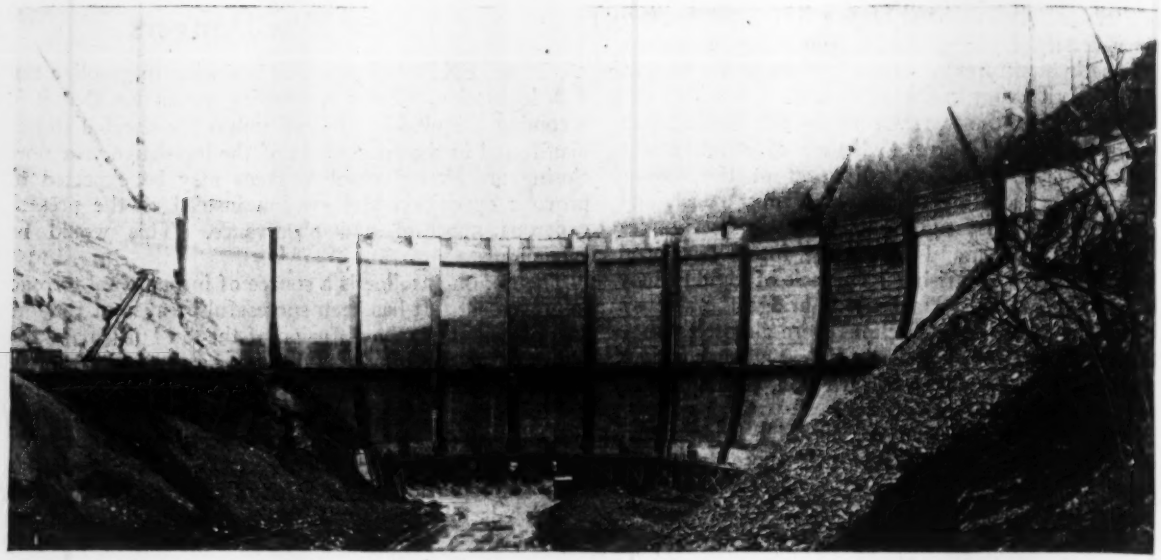


Fig. 1—Waterville Arch Dam Looking Upstream Showing Sectional Blocks Before Filling Joints

Design and Construction of High Arch Dam for Waterville Hydro-Electric Development

Revolving Cranes Place Concrete in Structure for 100,000 Kw. Power Project in North Carolina Mountains—Manufactured Sand and Tunnel Muck Used as Concrete Aggregates—Dam is Overflow Type with 180-ft. Free Drop

BUILDING a high thin-section arch dam in an almost inaccessible site in the Great Smoky Mountains of North Carolina presented many interesting construction features, one of which was placing 120,000 cu.yd. of concrete with two traveling full-circle cranes. Because no sand was available, crushed rock was used as fine aggregate, proportioned with two sizes of coarse aggregates, all crushed at the site. The dam is designed to give a free drop of 180 ft. to the overflow, which is controlled by tainter gates.

The project as a whole, located on Big Pigeon River near Waterville, N. C., as shown in Fig. 2, consists of the dam, the power house, and a 14-ft. pressure tunnel 6.2 miles long connecting the reservoir and power house. The power house is designed and constructed for the ultimate installation of three units having a total capacity of about 100,000 kw. The present and initial installation includes two units of 33,500 kw. each, operating under a static head of 861 ft. This article describes the design and construction of the dam. A subsequent article will feature the construction of the pressure tunnel, and two 650-ft. shafts. Construction of the dam has been completed and the tunnel and power house are scheduled for completion to commence operation in the latter half of this year.

The project is served by the Tennessee & North Carolina Railway touching at Waterville, the site of the power house. A narrow gage logging railroad running a short distance up Pigeon River was extended 5 miles up the canyon to provide access to the dam site, a dis-

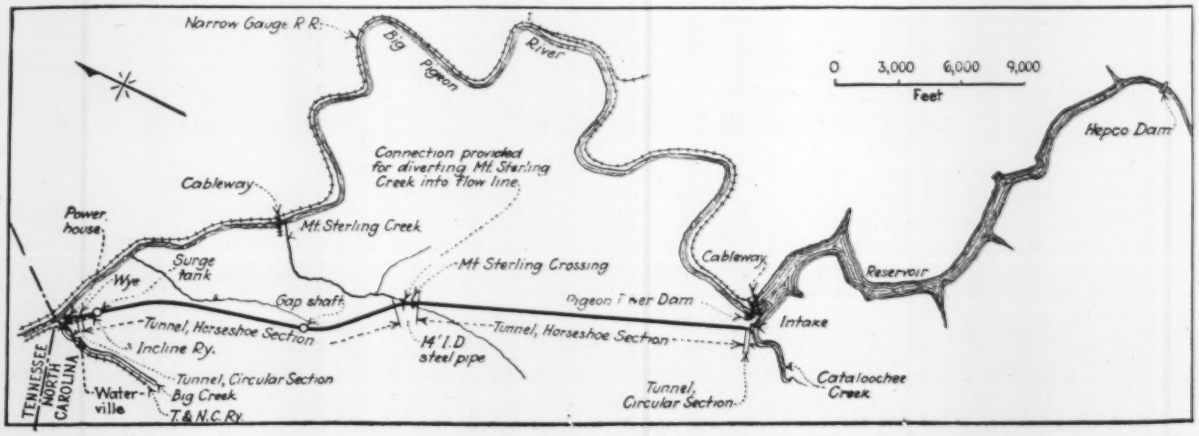


FIG. 2—MAP OF WATERVILLE HYDRO-ELECTRIC DEVELOPMENT

tance of 12 miles from Waterville, following the river. Before the narrow gage railroad was completed considerable heavy machinery had been skidded over mountain trails by tractors to permit construction on the dam and tunnel to get under way as soon as possible. When the railway was completed this was no longer necessary.

Design of Dam—The dam is situated in a narrow rocky gorge just below the junction of Cataloochee Creek and Pigeon River. The intake to the pressure tunnel is located on the creek, separated from the dam by a high rocky ridge. Plans and sections of the dam are shown in Fig. 4. In design the structure approaches the constant angle type, although it does not conform strictly to that type. At the center the dam rises 200 ft. from foundation to top of tainter gate piers (El. 2,267.5), but the spillway elevation is almost 20 ft. lower (El. 2,248). Fourteen tainter gates 24 ft. long control the water to El. 2,258. A detail of the spillway crest, tainter gate and gate piers is shown in Fig. 6. The tainter gates will be operated by three electrically driven 10-ton traveling hoists on tracks resting on the pier tops. As can be seen from Fig. 4, the thickness of the center section varies from 40½ ft. at the bottom to 16 ft. at the neck, flaring out to approximately 22 ft. at the spillway crest. The radius at the downstream side of the crest is 301 ft., except at the abutments. A base circle of 312 ft. radius lies entirely within the crest limits at all points. This circle was the basis of all surveys, working points for setting forms being laid out by angle and distance from points on this base circle.

At the center the overflow will have a free drop of 180 ft. A 4-ft. concrete protection wall built against the lower face is El. 2,107 and a concrete apron 70 ft. wide sloped slightly downstream are designed to prevent any tendency to scour.

Eight sluiceways 8 ft. wide and 20 ft. high carried the river during construction operations. Six of these were closed with stop logs, the other two were provided with swinging steel gates, as shown in Fig. 9. Provision for

FIG. 3—EARLY STAGE OF DAM CONSTRUCTION
Note position of two revolving cranes. Lower concrete track trestle under construction. Camp is shown in upper right.

concreting the sluiceway was made by placing two 12-in. pipes extending from the top of each sluiceway to the downstream face on a 45-deg. slope upward (Fig. 8). A 60-in. Johnson discharge regulator is provided on a pipe through the east abutment (Fig. 4). This will make it possible to lower the water level below the intake for maintenance purposes.

To insure tightness and to compensate for the shortening due to contraction of concrete the dam was built in twelve vertical sections approximately 50 ft. long with 8-ft. openings between each section. The openings also provided means of handling any severe floods that might have occurred during construction operations. They were filled during cold weather after the concrete had shrunk and at a time when the average age of the concrete was six months. A view of the dam before filling between the blocks is shown in Fig. 1. The ends of the arch segments were built normal to the arch thrust at all

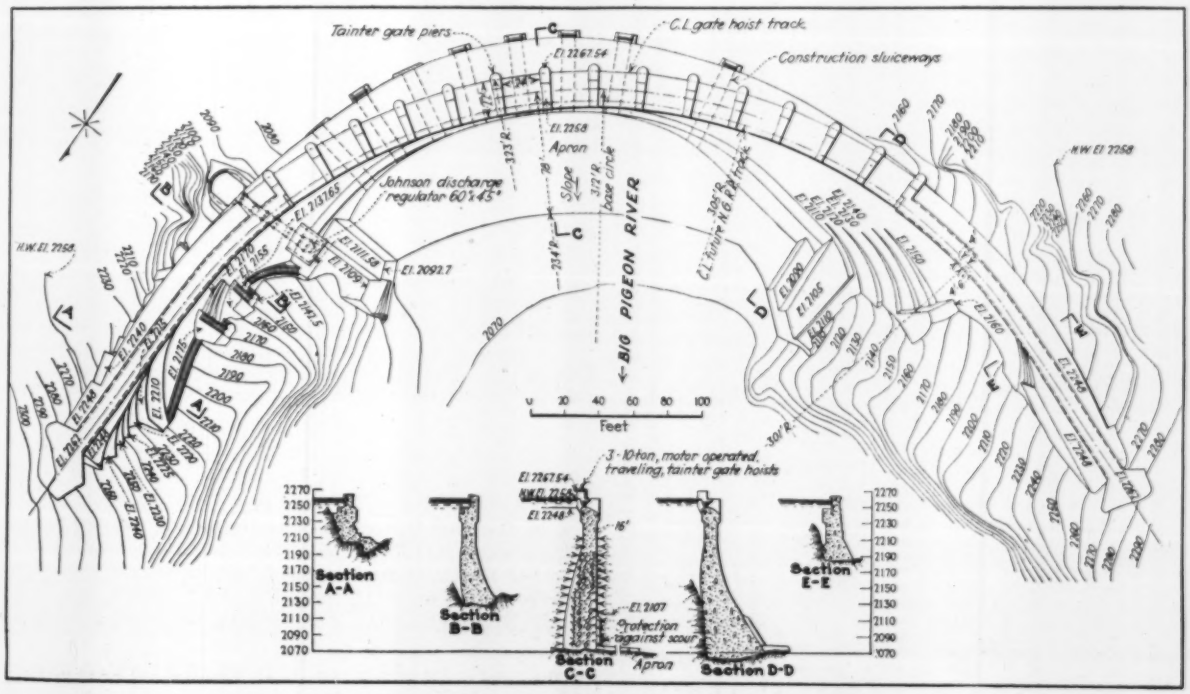


FIG. 4—PLAN AND SECTIONS OF WATERVILLE DAM

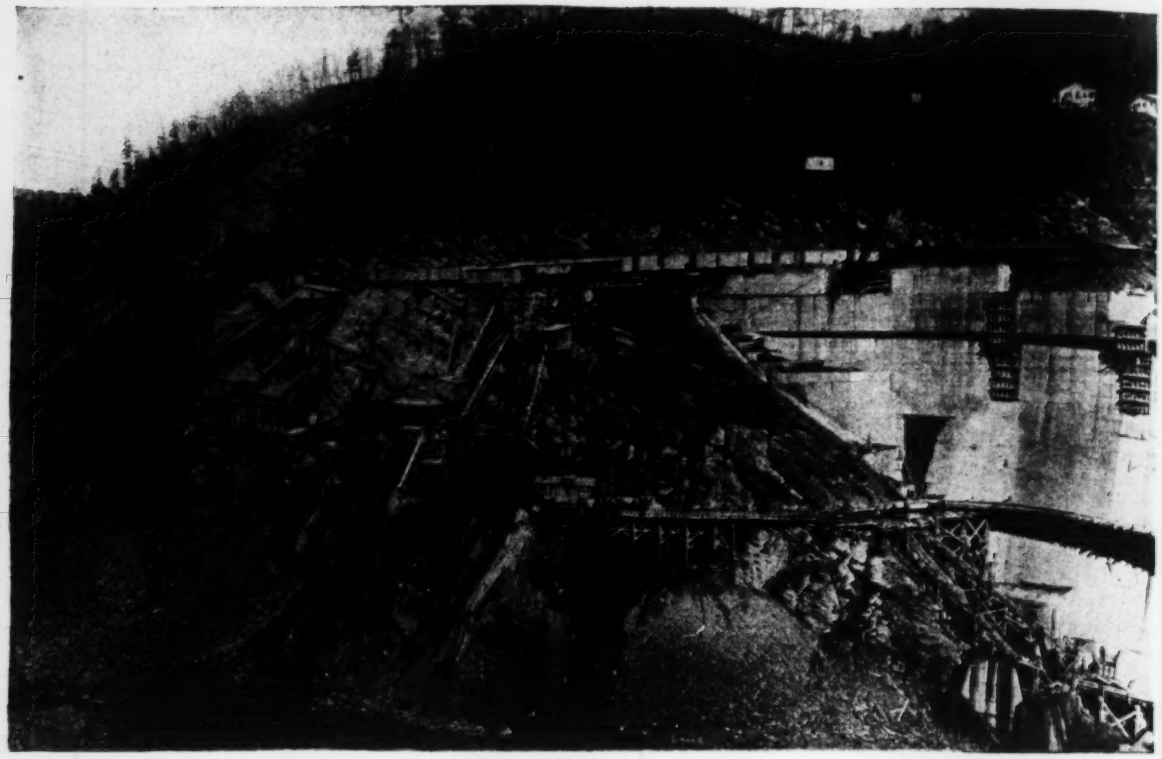


FIG. 5—CONCRETE AND ROCK CRUSHING PLANT, WATERVILLE DAM

points, resulting in peculiarly shaped warped surfaces. In addition to the usual keys, copper waterstop strips 12 in. wide were placed in all vertical joints, and sheet iron stops 6 in. wide were placed in the joints separating each day's work. Both kinds were placed 12 in. from the upstream face.

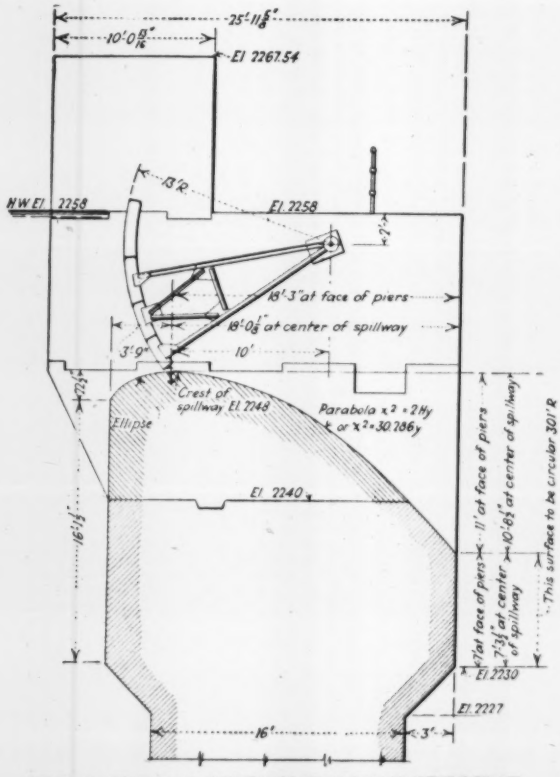


FIG. 6—TYPICAL SECTION THROUGH SPILLWAY SHOWING TAINTER GATES

Foundations and Grouting—Solid rock outcropped at the site on both sides and the floor of the gorge. In preparing the trench for foundations and abutments more than 35,000 cu.yd. of rock were excavated, most of which came from the lower sides of the gorge. The entire foundation and abutment area was grouted under 70 lb. pressure through holes drilled 15 to 20 ft. deep on 10-ft. centers.

Concrete Proportions—Crushed rock alone was used as aggregates. Most of the supply came from tunnel muck though a quarry near the mixing plant supplied some of the rock. The proportioning used for the most part in the dam is 1 : 2½ : 5, divided as follows by weight per 2-cu.yd. batch: cement, 900 lb.; fine rock, 2,675 lb.; medium rock (⅜ in. to 1 in.), 1,300 lb.; large rock (1½ to 3 in.), 2,475 lb. This gave a very dense concrete weighing approximately 161 lb. per cu.ft.

Railroad Construction and Operation—One of the most important rail connections for the work at the dam and the upper end of the tunnel is provided by the extension of the 3-ft. gage logging railroad up the river to the dam site. This line connects with the T.&N.C. at Hartford, Tenn., four miles below Waterville. As it will become the property of the T.&N.C.R.R. in the future and may be further extended upstream the piers on top of the spillway are designed to accommodate a spur extension across the river for local logging operations. All transportation of men, materials, machinery and supplies to the dam and intake portal of the tunnel is handled over the railroad by Shay geared steam locomotives. Engineers and officials travel over the railroad in small automobiles running on flanged wheels. These cars are equipped with additional front wheel brakes operated by turning the steering gear. All movements over the rail-

road are controlled by a regular train dispatcher on duty day and night. Telephones at every siding facilitate train operations.

Part of the transportation system is two cableways of 1,700-ft. span crossing the river, one at the junction of Mount Sterling Creek and the river, used by the tunnel contractor and the other just above the dam, used for both the dam and tunnel work. These cableways provide the only access from the narrow gage railroad to the tunnel operations. Both cableways are electrically operated.

Construction Plant and Operations—Considering the magnitude of the job, the plant layout is surprisingly simple and efficient. Except for gasoline dinkies, all equipment is electrically operated, current being brought in over permanent lines built to handle the eventual output of the power plant. A steel guy derrick was set high up on each side of the gorge at the dam site to handle the abutment excavation and assist in concreting. A steam shovel inside a rock crib cofferdam handled excavation in the foundations, the excavated material being hauled downstream over a temporary narrow gage road with gas dinkies.

During the early construction period the river was confined to a narrow channel along the west bank while the center portion of the dam was started. At the same time the east abutment block was completed and the east guy derrick set up on it toward the western edge. After the center blocks were well started a cofferdam closure of the remaining stream bed was made, the river flowing through sluiceways in the completed blocks and the openings between them. Work then commenced on concreting the western portion of the structure.

The concrete plant was hung on the east side of the gorge about 300 ft. downstream from the dam, the mixers being placed at approximately El. 2,160. From the mixers a track ran level along the cliff to the dam, extending along the downstream face of the structure on brackets, at a level about the midpoint of the dam's total height. This track was extended as each successive block was built up to the level of the track. A second

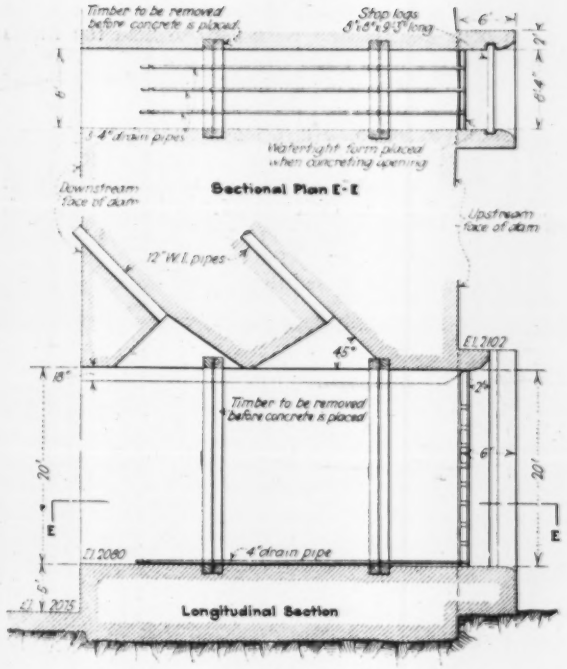


FIG. 8—TYPICAL SECTION OF SLUICEWAY

track was placed at the downstream toe across the river bed on a trestle at El. 2,093 (Fig. 7). Concrete was brought from the mixers in 2-cu.yd. bottom dump buckets on flat cars, hauled by gas dinkies, two cars to a train. Two full-circle cranes operating at different levels then handled the buckets to the forms. When necessary to use the lower track for distribution, the concrete was dumped into a hopper at the upper level, chuted to a hopper at the lower track and dumped into buckets on cars.

Using the two cranes proved to be a very satisfactory method of handling concrete. The cranes are electrically operated, have a capacity of 10,000 lb. at flat boom (radius of 75 ft.), and operate on a 14-ft. gage track. The track is made up in sections and is handled by the crane itself. The cranes were always kept at different levels for most efficient operation. At first one was in the river bed (Fig. 3) with the other one at the midpoint level. Later the lower one was moved to the crest level (Fig. 7). It was necessary to dismantle the machines when moving them from one level to another.

Forms—The concrete was placed in 5-ft. horizontal lifts in the lower portion of the sections, and in 10-ft. lifts in the thinner top part. The forms were made up in panels with 2-in. sheeting, 4x6-in. studs and 6x8-in. wales. To permit warping the panels, wedges were used between the

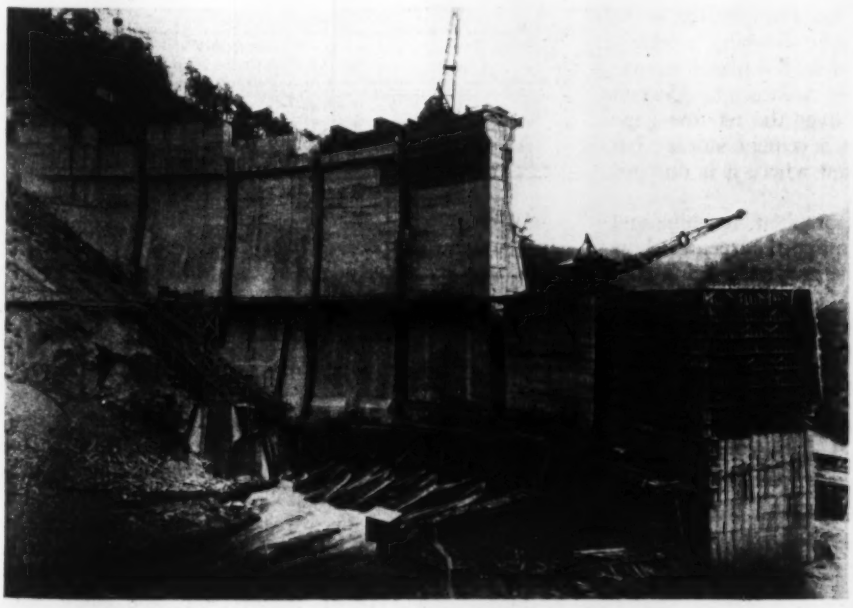


FIG. 7—WATERVILLE DAM IN INTERMEDIATE STAGE OF CONSTRUCTION
Note upper and lower concrete tracks, the upper hung on brackets anchored to the dam, and position of revolving cranes in comparison with Fig. 3.

studs and wales. Anchors were embedded in the top of each pour and tie rods were used to hold the forms in place for the next pour.

Concrete Plant — The complete electrically-operated crushing and mixing plant built on the side of the gorge can be shown in Fig. 5. All rock and cement was brought in on cars over the railroad track above the plant. Some tunnel muck was brought from the lower tunnel portal at Waterville, but most of it came from the intake portal. Muck cars from the tunnel were carried across the river to a point above the dam by the cableway.

The rock was first passed through a primary gyratory

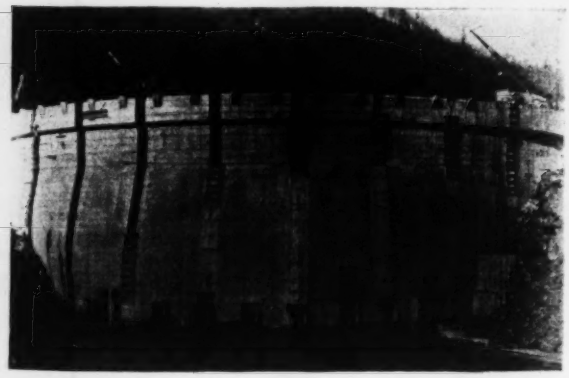


FIG. 9—LOOKING DOWNSTREAM, WATERVILLE DAM, SHOWING FILLING OF JOINTS

Gates for final closure of sluiceways can be seen ready to drop into position. Other sluiceways will be closed with stoplogs previous to filling with concrete.

crusher, then to scalping screens, to another gyratory crusher and a sand crusher. A belt conveyor then took the crushed material to separating screens, from which the three sizes of aggregates flowed by gravity to 750-ton storage bins. From the bins a single belt conveyor transported the aggregates alternately to smaller bins above the mixing plant.

A single weighing batcher plant served two 2-cu.yd. mixers placed side by side. The batcher bin gates were operated by compressed air. The weights of aggregates going into the batch were shown on a single dial scale, eliminating the usual beam setting in weighing batchers. Each batch was automatically held in the mixer a minimum of two minutes by a recording wattmeter. Cement in bags was brought up in cars over the narrow gage railroad, handled in bulk through a cement storage bin and then chuted to the mixing plant where it is dumped by hand.

At the dam are also a compressor plant, machine and drill sharpening shop, and a well-equipped carpenter shop.

Contractors and Personnel—The project is being constructed for the Carolina Power & Light Company by the Phoenix Utility Company under the direction of H. F. Lincoln, general superintendent, and D. F. Dow, resident engineer. Parker-Graham-Sexton, Inc., and the Pigeon River Tunnel Company, Inc., of Paterson, New Jersey, are the sub-contractors for the intake and tunnel. Robert E. Parker, general superintendent, has been in local charge of the work for the sub-contractors.

British Engineer to See Mississippi Works

Permission has been granted by the War Dept. to G. Clarke, Superintending Engineer, Burma, India, Public Works Department, to inspect flood-control works on the Mississippi.

Behavior of Timber Structural Framing Under Stress

Eccentric Location of Upper Story Columns—Checking of Floor Beams and Girders—Tilting of Unbraced Trusses

By S. E. Berkenblit
Structural Engineer, Chicago

IN BUILDINGS of structural timber construction it is usually difficult to insure continuity in the framing, the joints offering considerable trouble where appreciable loads are to be carried, so that timber framing is less adaptable than steel or concrete for taking care of secondary stresses. The behavior of timber carrying static loads to capacity and designed with standard unit working stresses shows ample margins of safety, a very appreciable amount of overload being ordinarily necessary before signs of weakness and failure become apparent unless the timber has organic deficiencies, such as knots or shrinkage cracks. In case of dynamic effects, however, such as impact and vibration, the organic characteristics of a fibrous material manifest themselves quite distinctly whenever stress is developed along the line of least resistance or in line with the fibers of the timber.

Examples of timber framing under stress, as observed by the writer are given in the following notes. In Fig. 1 is shown the design of a store built some years ago. Its first-floor columns 11¼ in. square, spaced about 24

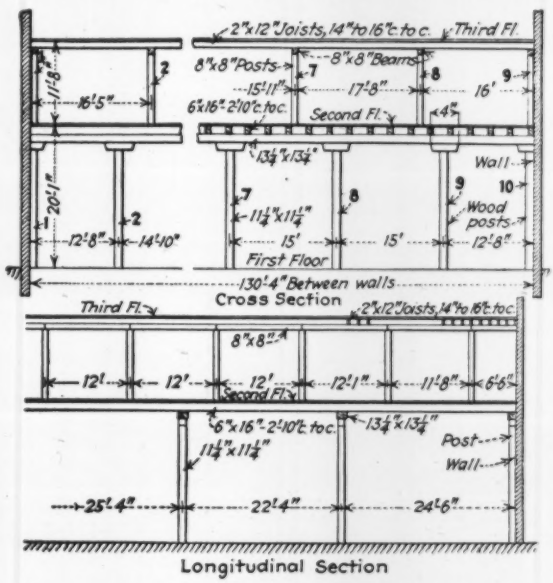


FIG. 1—COLUMNS WITH UNSYMMETRICAL SPACING

ft. longitudinally and 15 ft. crosswise, support girders 13¼ in. square and these in turn carry 6x16-in. beams spaced 2 ft. 10 in., with plank flooring. The floor is uniformly loaded with household furniture, except for aisles. Upon this floor are 8x8-in. posts carrying the third floor and placed without any reference to the supporting beams below. They are spaced about 12 ft. longitudinally and 16 ft. transversely, and carry 8x8-in. girders with 2x12-in. joists 14 to 16 in. apart, upon which is plank flooring. This floor is similarly loaded

with household furniture. All the joists are placed on top of the girders.

Analysis of stresses in the third-floor framing indicate that the joists are capable of supporting 85-lb. live load, while the girders can support only 17-lb. load per square foot of floor. The weight of furniture, including some walking load, would not exceed 17 lb. per square foot and with 13 lb. as the actual weight of floor, the total load is 30 lb. per square foot of floor on the 8x8-in. posts. For the second floor, the bending moment equals 636,000 in.-lb. on two joists, while the resisting moment of two 6x16-in. joists equals 624,000 in.-lb. at 1,300 lb. unit stress.

As shown in Fig. 1, the 8x8-in. posts are placed without regard to the joists supporting them and are generally supported by two joists directly. Only when one joist supports the post would it be considerably overstressed; but owing to continuity of the plank flooring it is reasonable to assume that even then it would only carry a major part of the load and would possibly be overstressed 50 per cent, while two joists would carry the load satisfactorily.

In the second floor, loaded in the same way as the third floor, the total floor load of 40 lb. is considered uniformly distributed over the girder and the second floor posts give concentrations of 6,000 lb. per joist. The resulting bending moment equals 766,000 in.-lb. while the resisting moment of the $13\frac{1}{4}$x$13\frac{1}{4}$-in. girder equals 505,000 in.-lb. at 1,300 lb. unit stress, resulting in 50 per cent overload.

This analysis shows that although the loads assumed are very light as compared to usual requirements for buildings of this kind (100 lb. live load for stores), they are practically the actual loads imposed and the framing would carry these loads at least with a safety

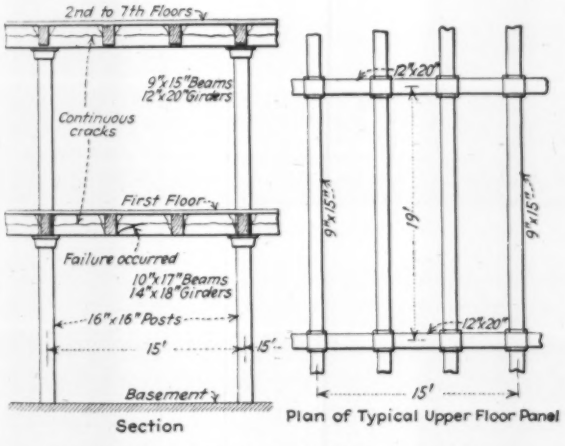


FIG. 2—CRACKS IN BEAMS AND GIRDERS

factor of 3. But a requirement of 100 lb. live load would mean a design with a safety factor of 16 in respect to actual loads.

Typical framing of a heavy 7-story warehouse of mill-type construction is shown in Fig. 2, in which the columns have steel caps and all beams are between the girders, being carried by stirrups. A noticeable feature on all floors was the presence of continuous horizontal checks in at least 75 per cent of all beams and girders. These checks ran as undulating cracks at about the neutral axis of the beams and in some cases appeared as open joints. Only in a very few instances were these cracks present on both sides of the beam or girder. In the sawtooth roof framing, the horizontal tie beams at the bottom of trusses had similar checks running full length of the timbers. The cracks were caused by shrinkage of the timber during a number of years and not by internal stresses induced by external loads.

The first floor framing consisted of 10x17-in. beams about 5 ft. apart, framing into 14x18-in. girders, the panel size being 15x19 ft. Investigation shows that the beams are safe for 250 lb. and the girders for 150 lb.

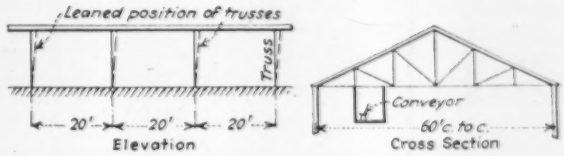


FIG. 3—UNBRACED TRUSSES TILTED BY VIBRATION

per square foot of floor. Typical upper floor framing consisted of 9x15-in. beams framing into 12x20-in. girders, both safe for 150 lb. live load.

An examination of actual loading made it clear that many of the upper floors were loaded to capacity. The question as to how much the horizontal cracks had impaired the strength of the beams and girders had to be settled before any strengthening of the floors was undertaken. Investigation of diagonal shear showed that in both beams and girders this unit stress was below 120 lb., which is within proper limits. There is little doubt that the horizontal checks were directly impairing the resistance of timber to diagonal tension, and when present on both sides of the beam would probably decrease its effective area 50 per cent.

Where floor framing of considerable area is involved and great care is to be exercised in deciding upon the number of pieces to be repaired under difficulties, the consideration of limiting the effective resisting area to at least 50 per cent of the original cross-section is practical and justifiable, assuming that no undue pounding is exerted on the floor. It would be necessary, of course, to carefully examine every piece of timber to determine its condition.

A noteworthy feature in this building was the shifting of the beams on the supporting hangers, as observed in many instances, due probably to shocks and vibrations set up by pounding loads. Portions of the first floor were heavily loaded with rolls of roofing paper, each roll weighing 90 lb.; a stack of two rolls vertically produces a unit load of 325 lb. and three rolls, 500 lb. per square foot of floor. A complete panel loaded partly two and three rolls high had a unit load of about 400 lb., overloading the beams 60 per cent without apparent effect. The front portion of this floor, which served as a receiving room, was loaded in the same manner, but vibrations and pounding due to handling of material increased the stress and resulted in a floor load of probably 500 lb.

The beams supporting this load apparently carry this 100 per cent overload satisfactorily, while the girders designed for 150 lb. per square foot began to show signs of weakness. One girder directly in the path of unloading operations finally failed by flexure, as shown in Fig. 2, a tension crack at the middle third directly at the bottom of the beam opening to about 1 in. wide. An attendant in the basement reported the danger and the loading was quickly removed. The

open joint in the girder subsequently closed and this girder was replaced.

Another illustration of behavior of timber under stress is in a fertilizer building where wooden trusses of 60 ft. span, Fig. 3, spaced 20 ft. c. to c., had neither cross-bracing nor bottom chord bracing between trusses. The trusses were supported by heavy timber posts as part of the wall framing of the building. A platform was suspended at one end of each truss to carry a light conveyor running the full length of the building. The purlins were 2x12-in., 16 in. apart, with $\frac{7}{8}$-in. sheathing under the roofing. The absence of bracing and the weak nailed connections between the purlins and top chords of the trusses, coupled with the continuous though slight vibration, had an inevitable effect on the static equilibrium of the structure. A gradual leaning of the trusses developed, as shown, until it assumed an alarming aspect and called for immediate action. The work of stopping this movement and strengthening the component parts of the structure was not only difficult but dangerous, due to its inaccessibility and the condition of the members.

Zeolite Water-Softening Plant at Mangum, Okla., Uses Open Basins Instead of Pressure Tanks

Raw Water of 30-Grains Hardness Reduced to 0.5 Grain Hardness and Mixed with 30-Grain Water in Ratio of 915 to 85 to Give Final Product of 3-Grains Hardness

By H. B. Crane

Principal Assistant Engineer, International Filter Company, Chicago, Ill.

Zeolite has been used successfully for some years in softening industrial water supplies. Increasing interest is now being shown in the use of zeolite for certain municipal projects wherever it may be used profitably alone or in combination with lime treatment. Practice in zeolite softening has been to use pressure tanks with an auxiliary open tank for handling the salt brine used for regeneration. The plant described in the following article employs upward-flow operation in open basins in place of pressure tanks. Water passed through the zeolite is softened to zero hardness and then mixed with a small amount of hard water to adjust the total hardness of the product supplied to the consumer. Complete mechanical equipment has been provided to insure flexibility, control, and operating efficiency. —Editor.

For a Number of Years Mangum, Okla., has obtained its water supply from five wells dug about 40 ft. into the sand overlying the Permian or "Red Beds" and walled with brick. The quantity of water obtained from them has always been sufficient for the city's needs, the deliveries varying from 200 to 300 g.p.m. per well. During the first years of use the water was fairly soft but the hardness increased with the water consumption until it became advisable to consider means for softening the existing supply or obtaining a new and softer one from a different source.

In 1927, the Edward W. Gantt Company, engineers, of Oklahoma City, was retained to investigate and report on water-supply conditions. A well supply, considerably softer than the one in use, was located approximately six miles from the city, but the cost of developing it did not compare favorably with a water-softening plant for the existing supply, and the latter was finally recommended by the engineers. Softening by lime and soda ash, by lime followed by zeolite and by zeolite alone were then considered. The latter, which was advised as most economical in first cost and operating expense, was adopted by the city and plans and specifications were prepared by the engineers.

The plant is of particular interest because of the unusual methods employed. The zeolite beds, which operate on the up-flow principle, are placed in open reinforced-concrete basins, instead of steel pressure tanks heretofore so extensively used for zeolite softening, and every facility is provided to insure flexibility, control and operating efficiency.

The normal capacity of the plant is 1 m.g.d., containing not over 3 grains of hardness per gallon expressed as calcium carbonate, based on handling raw water having a compensated hardness of 30 grains per gallon. Under these conditions, the zeolite beds will provide 0.915 m.g.d. containing not over 0.5 grain of hardness per gallon, and to this quantity of softened water will be added 0.85 m.g.d. of 30-grain water, the mixing of the two taking place as the waters enter the clear well. Means is provided for automatically proportioning the hard and softened waters.

Two zeolite beds are provided, 11 x 12 ft. in plan and 5½ ft. deep. They will be operated in four cycles per day, each consisting of 5.5 hours "run" time followed by a half hour for regeneration.

Triplex pumps lift water from the wells to a 0.25-m.g. surface reservoir and a centrifugal pump raises it from there to the softening plant. The low service pump has capacity of 1,200 g.p.m. or 1,728 m.g.d. when operating under a total head of 20 ft. Additional pumps noted later on handle both the brine and the wash water alternately.

Raw water enters the beds at the bottom after passing through Venturi rate-of-flow controllers and a manifold system equipped with umbrella-type distributing nozzles. The flow continues upward through 12 in. of graded gravel, then through 66 in. of zeolite, where softening takes place. Collecting troughs discharge the softened water over breast walls into gutters which lead to the 10-in. effluent main supplying the 0.25-m.g. reinforced-concrete softened-water reservoir.

A Venturi tube is installed in the 10-in. effluent main running through the pipe gallery. This tube is connected at inlet and throat to a diaphragm chamber, and this diaphragm is connected by levers to a second diaphragm

which actuates a Venturi rate-of-flow controller installed in a 4-in. hard-water supply line which also runs to the softened-water reservoir. This hard-water line is an extension of the force main which serves the zeolite beds through their rate controllers. The effluent Venturi tube and the controller in the hard-water supply line, with their interconnected diaphragms, automatically keep the quantity of hard water in direct ratio to the quantity of softened water being delivered to the reservoir. By this means the hardness of the water in the storage reservoir is maintained at 3 grains per gallon, as the two streams, one of zero hardness and the other of 30 grains hardness are mixed as the waters enter the reservoir.

Each softener bed is provided with four valves to control the influent, effluent, waste and regeneration. These valves are hydraulically operated from marble tables which contain also gages for indicating and recording the rate at which softened water is produced and likewise sampling devices.

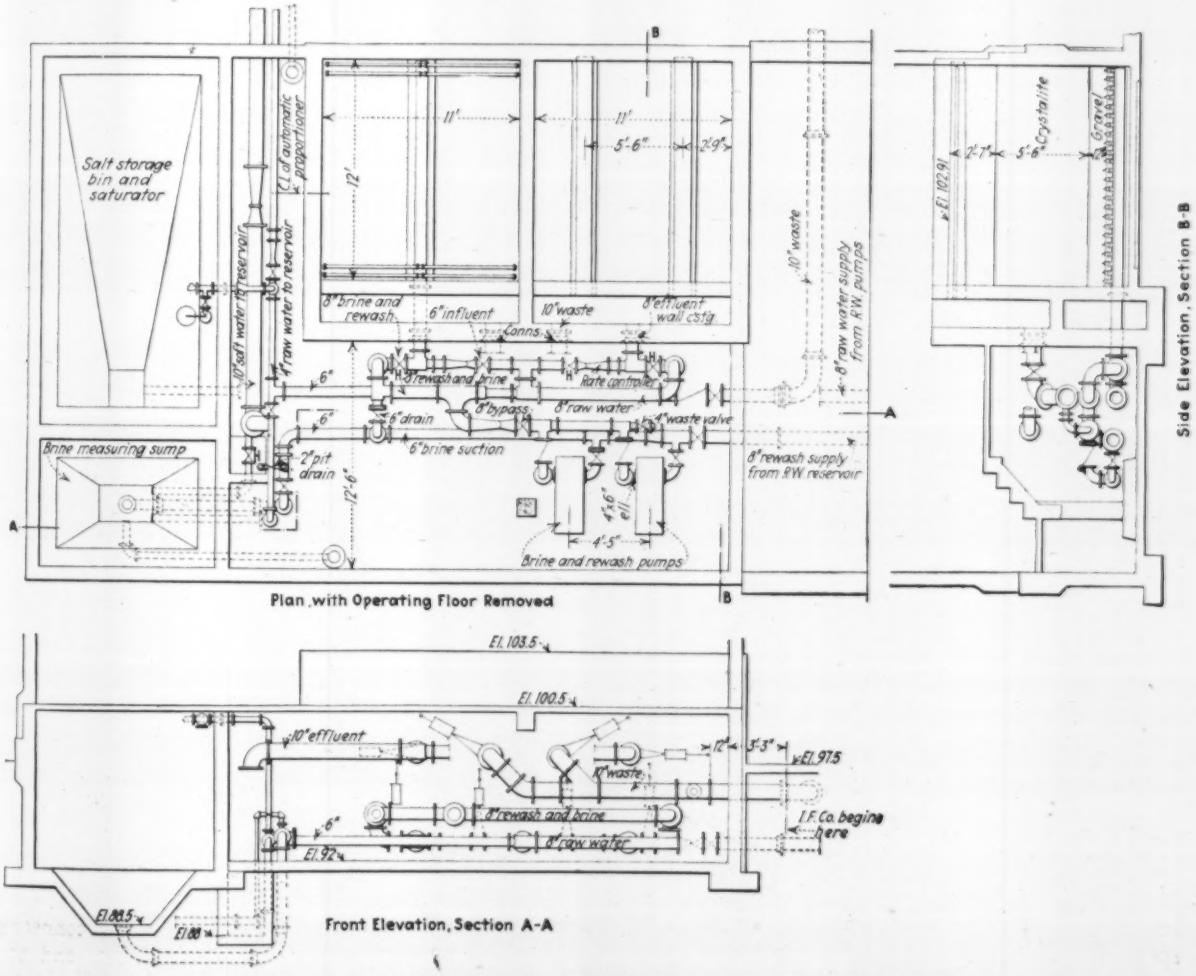
The salt for regenerating is stored in a reinforced-concrete saturator or bin built to the left of the softener basins. The top of this bin is at the same elevation as the top of the operating floor. It is 10 x 20 ft. in plan and $8\frac{1}{2}$ ft. deep with a salt capacity of about 80,000 lb. The bottom slopes to a sump built in the floor at one end, and a thin layer of gravel is spread over the bottom. The salt is always covered with water which is admitted to the bin through a float valve in the supply line.

A valved line connects the sump with a brine measuring pit located at one end of the storage bin. The measuring sump is 7 x 10 ft. in plan by 12 ft. deep, with its bottom sloped to the center.

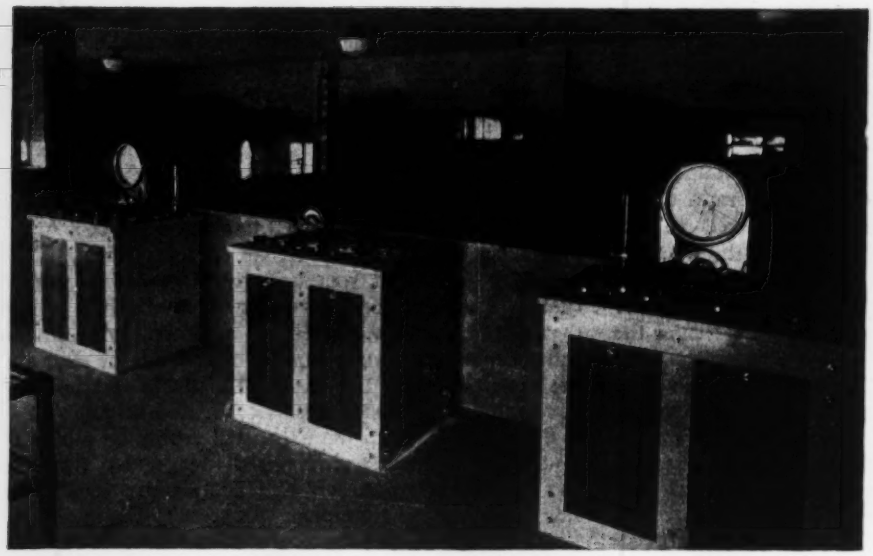
In preparing brine for regeneration, the valve in the line connecting storage bin and sump is opened and brine flows through the line from the one into the other. The brine being admitted contains approximately 26 per cent of salt by weight but is diluted to about 4 per cent in the measuring sump. A depth gage on the operating floor shows the depth of solution exiting in the measuring sump. The operator refers to a table which tells him that certain number of feet of saturated brine in the sump contains a certain number of pounds of salt, and the same table tells him the total depth in feet he must have for the necessary volume of diluted brine.

Brine is applied to the exhausted zeolite by means of centrifugal pumps, and is distributed under the beds through the same headers and laterals that handle the raw water during softening. As soon as the measuring sump is emptied, fresh water is applied to wash the brine up through the zeolite, complete the regeneration and remove the waste products resulting from the chemical reaction between the brine and exhausted zeolite. This waste is removed at the top through the same troughs that collect the softened water and is disposed of to the sewer.

The rate at which the beds are washed is about 2.7 times that at which the brine is applied, and approxi-



PLAN AND SECTIONS OF ZEOLITE WATER-SOFTENING PLANT AT MANGUM, OKLA.



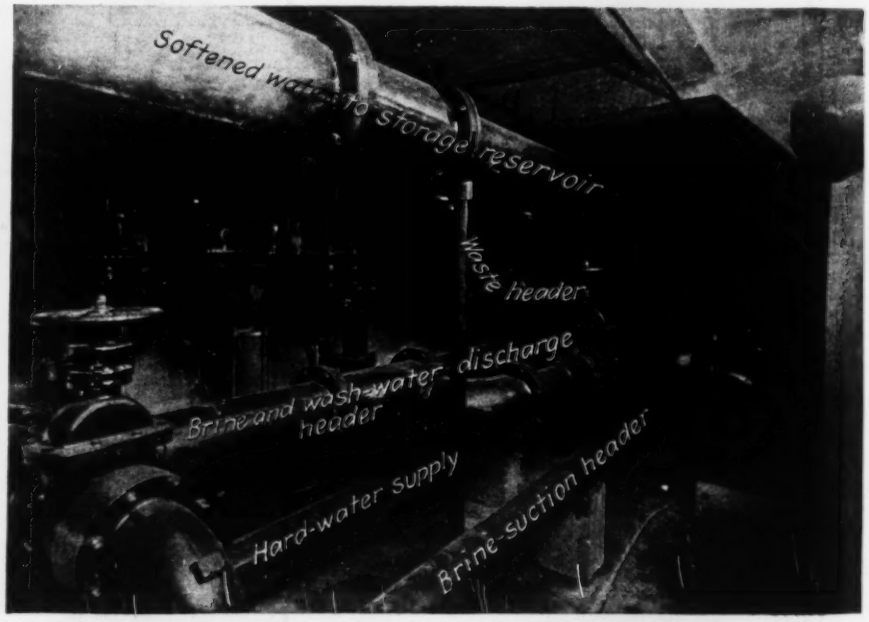
OPERATING FLOOR OF ZEOLITE WATER-SOFTENING PLANT, MANGUM, OKLA.
Softener basins behind operating tables. Basin for producing brine for regenerating zeolite at left of softener basins. Of the three operating tables, those at right and left are for the filters; middle table controls brining and washing zeolite.

mately the same ratio exists between the wash rate and the normal operating rate during softening. Hard water is used for washing, and had to be supplied either by the low-service pump or by an auxiliary provided for washing purposes. It was not good economy to install a low-service pump with sufficient capacity to take care of the peak load that would be thrown on it with one softener bed in operation and the other being washed, as this peak-load operation occurs but eight time daily during the regenerating periods for the two beds. Therefore two centrifugal pumps were provided, used for either service, one pump to be operated during brining and both thrown on the line to supply the wash water. These pumps are located in the pipe gallery and a suction line is provided that runs through from the brine-mixing sump to the surface storage reservoir supplying the hard water. Hydraulically operated valves are installed in the line so that the suction can be taken from either source, depending upon whether the pumps are being used for brining or washing.

With the pumps located as they are, a rather unusual set of operating conditions was found to exist on account of the wide variations in quantities of liquids handled and because part of the time, during either operation, the suction might be above and part of the time below the pump intake. During brining approximately 400 g.p.m. are required and the total head varies between 20 and 12 ft., this difference of 8 ft. being due to variations in the elevation of suction liquid with respect to the pump intake, from 2 ft. positive head to 6.5 ft. suction lift. During washing, 1,000 g.p.m. are required and the total head variations possible are from 34 to 21 ft., this difference of 13 ft. being due to possible variations in elevation of suction liquid, from 9 ft. positive head to 4 ft. suction lift. The units selected are centrifugal pumps each having a capacity of 525 g.p.m. at total head of 40 ft., direct-connected to 7.5-hp. electric motors. While brining, either pump may be operated, the required delivery being obtained by throttling the discharge valves. Both pumps are thrown on the line during washing, their combined capacities being but slightly in excess of the quantity required at maximum load.

All operations connected with brining and washing are controlled from a third operating table located on the operating floor between the softener-operating tables. This control table is equipped with levers and indicators for four hydraulic valves controlling the following functions: One valve regulates delivery of saturated brine to the brine measuring sump; another admits hard water to the measuring sump for diluting saturated brine; another controls the brine suction and the fourth, the suction line supplying hard water for washing.

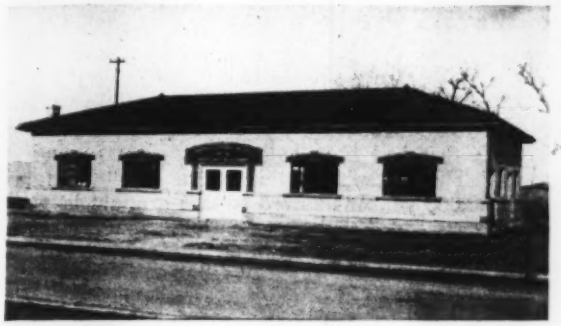
Two sets of push-button controls are also built into the table top. One set is wired to a double-throw switch underneath the table so that either pump may be used for brining, and the other set starts and stops both pumps for washing. A gage is also mounted here to indicate the rates at which brine and wash water are



VIEW OF PIPE GALLERY AT MANGUM SOFTENING PLANT

used. It is operated by a mercury chamber connected to a Venturi tube in the pump discharge header. Thus the operator can tell at a glance from the gage before him the rate at which the pumps are operating and can control the delivery by manipulating the proper valves.

A float switch is installed in the brine-measuring sump and is wired through the control table to the circuit operating the pump motors. This switch is set to make and break the circuit at high and low levels and is an additional safeguard against careless operation. It is provided to keep the pumps primed and prevent air working through the suction line and into the distribution piping under the zeolite beds, a condition that might occur if the operator neglected to watch the depth gage closely, and failed to stop the brine pumps when the gage showed that the brine had reached zero level in the sump. When the sump is full, the float rides at high level, the circuit is closed, and either pump can be started from the push buttons on the control table. When the float reaches zero level it throws the switch and breaks the circuit. The pump can, however, be started again by



EXTERIOR VIEW OF MANGUM WATER-SOFTENING PLANT

The right hand 23 ft. of the building is used to store supplies of the water and light departments, the municipal electric light plant being on the same plot of ground as the softening plant.

the other set of push buttons on the table when the beds are ready for washing. A pipe is run from the soft-water storage reservoir to the plant and connected to a float tube and staff gauge located in a conspicuous position, so that the operator can tell at all times the depth of softened water in the reservoir. The only test required for operation of the plant is the standard Boutron and Boudet soap test.

The surface reservoir, 60 ft. in diameter, now used for storing the hard water, existed before the plant was built. When water softening was decided upon it was considered advisable to cover it. The engineers designed a rather novel cover in the form of a segment of a spherical shell, with a 6-ft. rise at the center.

The water-softening plant and the hard- and soft-water reservoirs are built on one of the residence streets not far from the business district, on the same plot of ground as the municipal electric light plant. The softening plant is housed in a substantial pressed brick structure, trimmed with native red granite. The building is 65x31 ft. in plan. The west 23 ft. is a storage room used by the city for water and light department supplies, and the remainder of the building is occupied by the water softening plant. The total cost of the latter was approximately $45,500, including engineering.

Three motor-driven centrifugal pumps are available for high-service pumping. One has capacity of 500 and the other two 750 g.p.m. They are installed in the light plant and pump the softened water from the surface reservoir to a 60,000-gal. tank. The city is now considering the advisability of increasing the elevated storage capacity to 0.3 m.g.

Water consumption for the year 1928 averaged 0.446 m.g.d., with a maximum of 1 m.g.d. during the height of the cotton ginning season, and an average peak load of about 0.6 m.g.d. The water is distributed through ten miles of cast-iron mains and 1,300 service connections.

Construction was started November 1, 1928, and was completed March 1, 1929.

All the structural work was done by the city, under H. M. Renner, city manager. The zeolite, control tables, gauges, rate controllers, plant piping and operating valves, and the brine and wash-water pumps were furnished and installed by the International Filter Company, Chicago.

Refuse Used for Land Reclamation at Dundee, Scotland

RECLAMATION of low-lying land, subject to inundation, is being carried on by the city of Dundee, Scotland, and at the same time the city is getting rid of its mixed garbage and other refuse. The land, which is located in four places, is privately owned. The owner has promised W. H. Sagar, cleansing superintendent of Dundee, according to a letter by him in *Municipal Engineering* for Feb. 14, 1929, that if the land is satisfactorily filled it will be presented to the city as a recreation ground for the children of the district in which the land is located.

Mr. Sagar says that he is "working on the layer system so as not to tip more than 6 ft. deep at any one time; also working on a small face and keeping good covering o fclean ashes, earth or sand, in addition to covering the face of the tip each night before leaving work." [This appears to be in effect the "sanitary fill" method of garbage and refuse disposal that has been in use for many years at Seattle, Wash., and Ottawa, Ont.; see *Engineering News-Record*, Nov. 23, 1922, p. 876; April 26, 1923, p. 760, and July 2, 1925, p. 11, regarding Seattle, and Jan. 18, 1923, p. 106, for details as to Ottawa. Both cities abandoned incinerators for sanitary fills, Seattle closing two plants in 1913 and a third in 1915, Ottawa making the change in 1918.]

The land being filled at Dundee is located "behind a railway embankment, into which the tides rose at high water and during ordinary tide left it full of green slime and mud." This method of refuse disposal now being used supersedes one by which the refuse was first accumulated in huge heaps, from which it was carted away by farmers for use on agricultural lands. These "'stances' or middens in different parts of the city" sometimes towered 15 to 20 ft. into the air and amounted to "hundreds of tons," piling up "during the months when it was inconvenient for farmers to take the material straight to the land." Mr. Sagar states that in past days "after the manure had rotted in this way for several months, and especially during the frosty weather, the farmers' carts were busy in large numbers taking away the refuse into the field, and one can imagine the stench which was caused during such periods." In recent years the sale of this material fell off considerably, "owing to the ever-increasing amount of paper, bottles, tins, etc., so that it became necessary to get rid of about 120 [long] tons of the material per day. This is being accomplished by the fills being made at four locations."

Repair of Breaks in Outlet Tunnel of Rock-Fill Dam

Rock Pockets Behind Lining of Pressure Tunnel of North Bowman Dam Cause Ruptures—Grouting Supplements Repair—Intake Gate Added

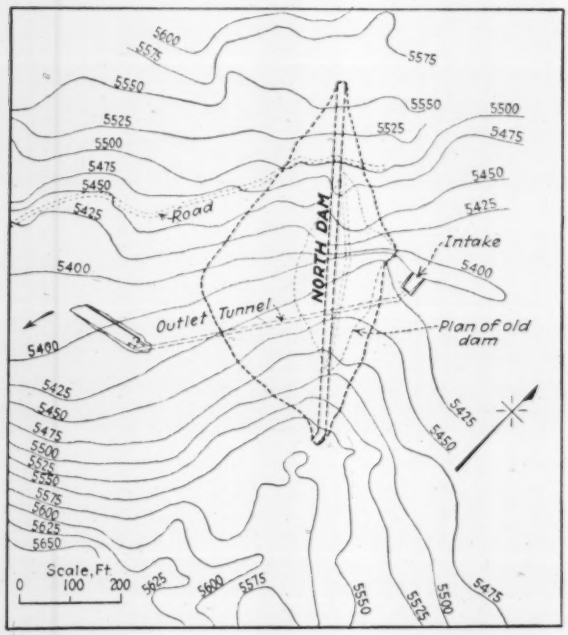
By Fred H. Tibbetts
Consulting Engineer, San Francisco, Calif.

EXCESSIVE leakage developed suddenly last summer in the outlet tunnel of the North Bowman dam when stored water for the first time attained a depth of 145 ft. The dam was completed in 1927 and is a rockfill structure 170 ft. high which stores water for the Nevada Irrigation District in Nevada County, Calif. The leak was plugged temporarily by small wood blocks pumped into the tunnel, this expedient preventing loss of storage and making it possible to hold the lake full until the beginning of reservoir releases for irrigation and power demands.

In the late fall, when the reservoir was empty, the outlet tunnel was unwatered and several breaks in the lining were found beyond the downstream toe of the dam. These were repaired, and as a further safeguard control of the tunnel at its upper end was provided by a roller gate operating on the upstream face of the dam. No leakage had appeared up to May 18, 1929, at which time the stored water had reached a depth of 100 ft.

A news report of the leakage appeared in *Engineering News-Record*, Oct. 11, 1928, p. 563. In the following are reviewed the conditions to which the leakage is ascribed, and also the method of repair employed.

When construction of the dam was commenced in 1926 it was first necessary to remove a rock-fill dam 90 ft. high that had been built in 1876 for mining purposes. The material in this entire structure, totaling about 50,000 yd., was moved so that it might be washed and the embedded timbers taken out. Practically all of the yardage was used again in the present structure,



PLAN AND SECTION, SHOWING OUTLET TUNNEL LOCATION

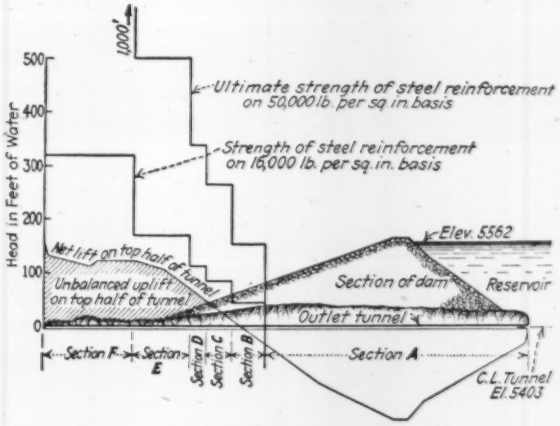


DIAGRAM SHOWING METHOD OF DETERMINING THICKNESS OF LINING

which contains about 310,000 cu.yd. of rock. Of this total, 28,000 cu.yd. was placed by derrick as a facing on the upstream side; the facing, which is about 25 ft. thick at the base and 6 ft. at the top and is surfaced with concrete from 8 to 12 in. thick, made it feasible to use a much steeper slope than otherwise would have been possible. The upstream slope is ¾ to 1 from the base up to 32 ft. below the top above which point the slope is ½ to 1. The downstream slope is 1⅔ to 1.

Outlet from the reservoir is by means of a 6-ft. tunnel driven through the rock under the south end of the dam. As originally built this tunnel had at its upper end a grizzly but no gate or other means of closure; regulation of flow was accomplished by two 42-in. outlets at the discharge end, one of which is controlled by a

UPSTREAM FACE OF THE DAM DURING CONSTRUCTION
Concrete facing poured from buggies operated on runways and delivering through chutes

needle valve, and both of which have butterfly valves. In its upper part the tunnel is lined with gunite only; farther down a concrete lining was poured in forms, with an amount of reinforcing steel varied to suit the increasing unbalanced pressure; and at a point about 86 ft. from the outlet structure a 6½-ft. steel pipe is anchored in the concrete and leads to the outlet valves. The total length of the outlet tunnel is 478 ft., in which the kinds of lining used were divided as follows:

Section	Length, Feet	Lining	Thickness, In.	Circumferential Steel Reinforcing Size, In.	Spacing, In.
A	256	Gunite	2	None	
B	32	Poured	9	⅜	8
C	24	Poured	9	1	12
D	17	Poured	9	1	9
E	63	Poured	9	1	6

Longitudinal reinforcing bars ½ in. square on 18-in. centers were used throughout sections B, C, D and E. Section F, which is 86 ft. long, has imbedded in its lining a steel pipe 6½ ft. in diameter and $\frac{5}{16}$ in. thick. This pipe has an inside coating of gunite on wire mesh 3 in. thick and is backed by concrete with a minimum thickness of 6 in.

The amount of reinforcing necessary in each of these portions of the tunnel was calculated from the upward or unbalanced pressure due to a full head of 195 ft. (which will occur when in the future the dam is raised 30 ft.) less the weight of the overlying material (figured for solid rock in place as 2.8 times the weight of water, and for loose dumped rock as 1.5 times that weight). This basis of calculation, of course, assumes that the lining has a uniform and firm support against the rock through which the tunnel passes. Allowable steel stress were taken as 16,000 lb. per sq.in.

The rock through which the tunnel passes is a granite somewhat shattered in places, but as it was thought to be a substantial backing for the lining no grouting was done. In the lower portion, near the downstream toe of the dam, the tunnel is about 20 to 25 ft. below the natural rock surface. The tunnel had been completed and was under pressure when construction operations on the main dam were under way. Thus heavy rocks up to 10 or 15 tons in weight were dumped over a bank 40 to 50 ft. high near this pressure tunnel and it is believed that the resulting shocks and jars may have caused some cracking or loosening of the granite through which the tunnel passes.

The dam was completed in June, 1927. During the following winter the average depth of water in the reservoir was about 100 ft. above the floor of the outlet tunnel and no abnormal seepage appeared. In the following season, however, on May 7, 1928, the reservoir water level rose to a depth of 145 ft. above the tunnel. By the time this level was reached leakage as much as 25 sec.-ft. was flowing from the vicinity of the lower end of the tunnel below and to one side of the downstream toe of the dam. As the head increased to a maximum of 162 ft., the leakage suddenly increased from 35 sec.-ft. to 107 sec.-ft. within a period of nine days. After the head reached its maximum (162 ft.) it then remained constant and the maximum leakage of 107 sec.-ft. also remained unchanged in quantity for about seven days, during which time preparations were being made for emergency measures in plugging the leaks.

The method used in cutting down the leakage consisted in anchoring a barge in the reservoir over the tunnel inlet and putting down a 4-in. pipe with an elbow at its bottom which could be inserted between the bars of the intake grizzly. Small wood blocks were then placed in the top of this pipe, and water was pumped through the pipe to force the wood blocks into the conduit. The blocks were chiefly cubes ranging in size from ¼ to 1 in. and were made by splitting up the short lengths

FLASHLIGHT OF THE MAJOR BREAK IN THE LINING
Three breaks occurred over rock pockets, the 160-ft. head exceeding the strength of unsupported lining.

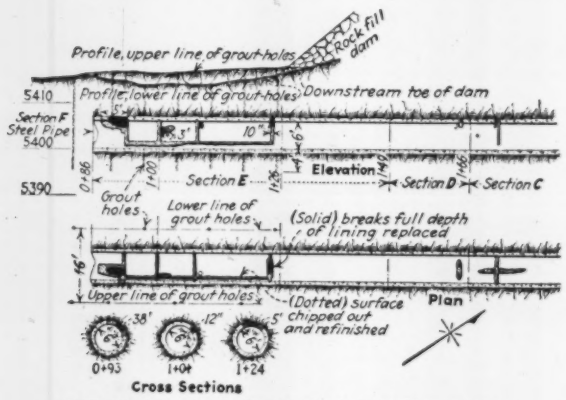
of timber secured by making saw cuts 1 in. apart. As soon as three or four bushels of these blocks had been pumped into the tunnel the leakage decreased to about 53 sec.-ft. It did not again exceed that figure, although the reservoir continued full, with a total head on the tunnel of 162 ft. This proved that the leakage had come from limited areas in the tunnel, which were effectively

GENERAL VIEW OF NORTH BOWMAN DAM

choked by the wooden blocks. Operation of the irrigation works was then continued throughout the season without concern about the safety of the tunnel.

During the period of maximum leakage very careful observations were made upon a number of points over the tunnel and adjacent area through which the leakage was coming to the surface. No horizontal movements could be detected. A small slab of rock, bounded by fractures through which the bulk of the leakage was reaching the surface to one side of and below the tunnel, was observed to raise a maximum of about 0.2 ft. This slab of rock again subsided when the leakage was reduced by the use of wooden blocks.

When unwatering permitted inspection of the tunnel in November, 1928, holes were found through the lining at three points near the outlet end where reinforcing



LOCATION OF BREAKS IN TUNNEL LINING

steel was spaced 6 in. on centers and the thickness of the concrete was about 9 in. The estimated total area of these three breaks was about 3 sq.ft., which was found to check roughly with the area that would pass the estimated leakage under the full reservoir head.

In each of the three breaks a rock pocket, such as would be caused by overbreak, was found behind the ruptured lining. There is little doubt that the break was caused by pressure on the concrete lining at these points greater than it could withstand without the support of solid backing. There is also, of course, the possibility of some localized defect in the lining or material of poor quality. However, it seems certain that if the lining had been thoroughly grouted the breaks could not have occurred.

Repairs were made by cutting out broken concrete to leave the steel exposed for effective bond and then entirely filling the openings with gunite shot into place with the cement gun. All spots where the concrete showed indication of weakness or breakage were repaired by chipping out and guniting, after which the lining was thoroughly grouted wherever extensive repairs were made.

Observations made during the period of maximum leakage indicated that 70 per cent of it was coming from a zone well below the bottom of the dam and 60 ft. to one side, at a point where the overburden on the conduit was about 20 ft. It was this part of the conduit that would have suffered most from the shocks transmitted to it during the construction of the rock fill. Grouting was therefore done from the surface around this part of the tunnel through eight grout holes driven down vertically 20 to 30 ft. below the surface.

It is believed that the design of the conduit lining is such that there was at no time danger of the sudden release of a flood; the worst that could have happened would have been a leakage serious only in terms of lost storage water.

The incident is of value in emphasizing the importance of pressure-grouting all conduits of this sort to insure uniform and adequate support. Another point is the importance of adequate control works at the *intake* end of a pressure tunnel, by way of the safeguard thus provided if it should be necessary to unwater the conduit during periods of storage. In this case any feasible type of intake tower seemed to be too costly, but in addition to repairing the conduit approval of the district was secured for installing a roller gate which could be lowered down the upstream face of the dam to close the tunnel intake.

Plans for the North Bowman dam were prepared by the writer and approved by M. M. O'Shaughnessy, consulting engineer, and by W. H. McClure, then state engineer. The dam was constructed under contract by the W. A. Bechtel Co., San Francisco. Plans for repairing the tunnel and installing the gate were worked out by the writer in conjunction with L. C. Hill and Fred C. Herrmann and were approved by Edward Hyatt, Jr., state engineer. The work was directed by Raymond Mathew.

Retaining Walls and Heaving Under Study

New retaining-wall and soil-research work at the Massachusetts Institute of Technology includes several interesting items, according to a recent statement by Prof. C. M. Spofford. Under agreement with the New England Power Construction Company, the Institute will make experimental studies of earth pressure on retaining walls, with special view to measuring the intensity of backfill pressure, effect of surcharge, effect of saturation and value of various means of drainage. The Institute will furnish the site and foundations, together with miscellaneous facilities, while the company will build the structure above foundations and provide the bins and loading and measuring devices. As a separate research, a study of the heaving of soil under frost action is being carried on as a piece of co-operative work between the department of soil mechanics and the U. S. Bureau of Public Roads.

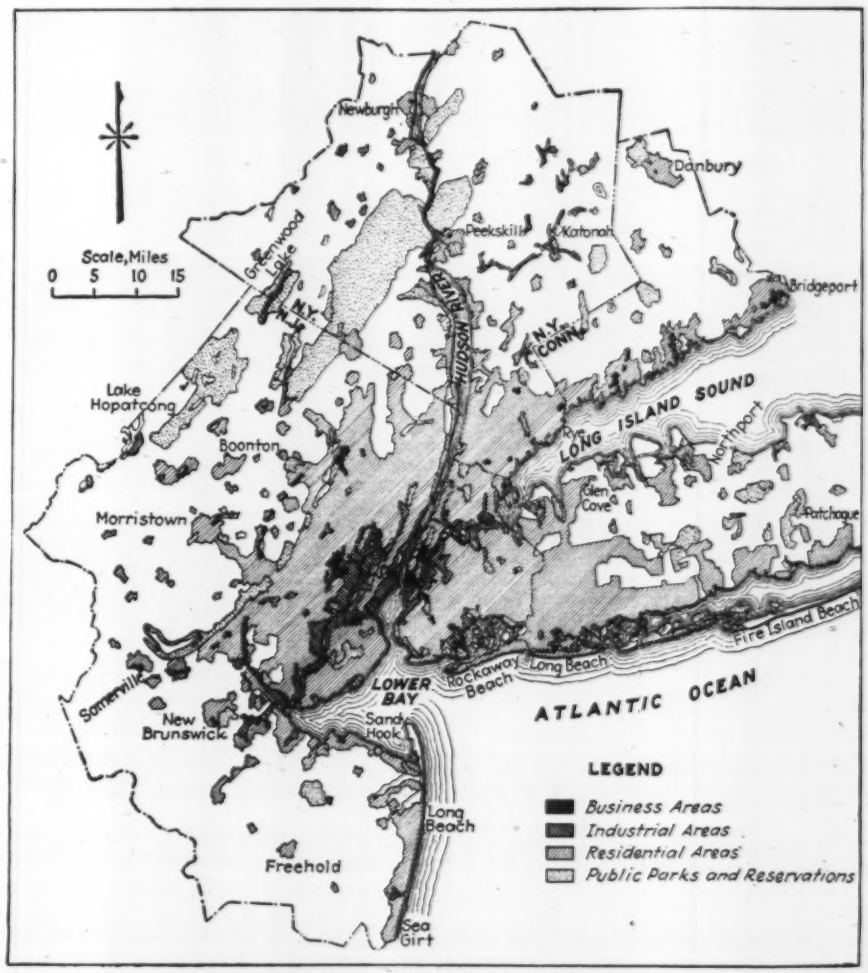
Regional Plan for Area with Twenty Million Population

Graphical Presentation of 7-Year Study of Highway, Suburban Rapid Transit, Trunk Railroad, Waterway, Airport and Other Needs of New York and Environs in 1965

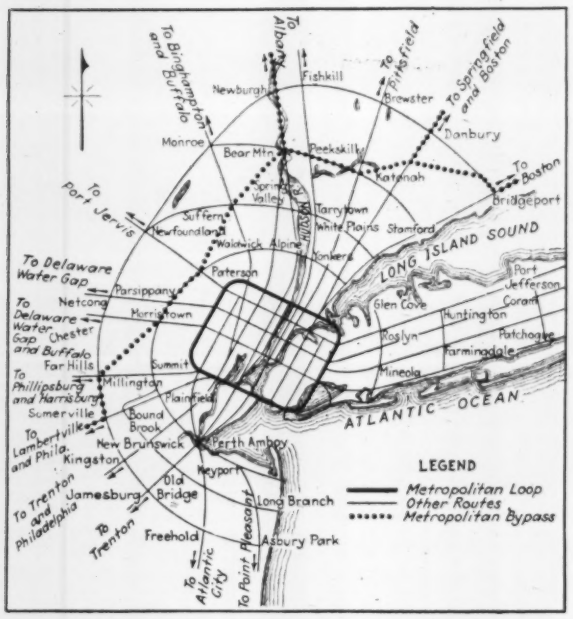
RESULTS of seven years of intensive study by engineering and other specialists working under the direction of the Russell Sage Foundation Committee on Regional Plan of New York and Environs, latterly with Frederic A. Delano as chairman, were outlined at the United Engineering Society Building on Monday evening, May 27. The region embraces 436 cities and towns in 22 counties located in the states of New York, Connecticut and New Jersey. It has an area of 5,528 sq. miles or as large as the State of Connecticut, a tenth the size of England and 250 times as large as the Borough of Manhattan, the center of the region. The cost of the work, met by the Russell Sage Foundation, is about $1,000,000. The plan was officially presented to some 2,000 invited representatives of the New York Region, who filled the auditorium and overflowed to a large hall above. Details of the Graphic Regional Plan, as it is called, will appear in two large volumes, one completed, the other scheduled for November of this year. The portions of the plan presented last week deal chiefly with major ways and means of circulation — highways, rapid transit, trunk railways, waterways and airports. Parks and parkways and land uses, which include zoning, were also outlined. Eight of the graphic plans shown on the screen at the meeting and included in the first volume of the Graphic Regional Plan, are here reproduced, together with summaries of portions of the first volume.

The present population of the New York Region is some 10,000,000 or half of that estimated for 1965. Of the present 10,000,000, about 6,000,000 live within the city of New York on an area of 298 square miles. The population density ranged in 1925 from about 104,000 per acre in Manhattan to 45 in Rockland County. Available for street traffic within the region in 1926 were 421,000 passenger automobiles, 107,000 trucks and 34,000 motor buses and taxicabs. New York City alone had 8,900 miles of streets in 1929, of which it is estimated that a little under 3,000 miles were paved. Rail facilities in the region include 12 trunk railroads and 1,890 miles of right-of-way. Of 243,500,000 passengers carried in 1924, some 170,000,000 or nearly 70 per cent were commuters. In 1925 there were 690 miles of rapid transit track in the region. In 1928 rapid transit lines in New York City carried about 3,500,000,000 passengers. Already there are 32 airports in the region.

Of the seven years devoted to the survey, there was something like a year of preliminary work by the late Nelson P. Lewis, formerly chief engineer of the Board of Estimate and Apportionment of New York City. This was followed by six years of study of the area, divided into six sectors. These sectors were in charge of the following specialists in city and regional planning: Frederick Law Olmsted, Thomas Adams (chairman of the Advisory Planning Group and Director of the regional plan studies), John Nolen, Harland Bartholomew,



LAND USE MAP OF NEW YORK AND ENVIRONS



DIAGRAMMATIC SCHEME FOR HIGHWAY ROUTES

George B. Ford and Ernest B. Goodrich in collaboration and Edward E. Bennett.

The general object of the regional plan and the premises on which it was based are stated in the report as follows:

Objects—The object of making the Plan [is] to give guidance to the people of the Region and the governing authorities that represent and act for them, to enable them to so direct urban growth in the future that the greatest practicable measure of health, safety, convenience and general welfare will be secured for the inhabitants. This object includes the obtaining of an adequate and well co-ordinated system of ways of communication, a well balanced distribution of land uses and such degrees of order and beauty in the art of building, as well as in the preservation of a spacious natural environment, as will conduce to wholesome living and working conditions.

It may be frankly stated that the only real hope of achieving this object lies in the application of preventive measures, particularly in those areas where new developments or extensive reconstruction are likely to take place. Half-hearted schemes designed to ameliorate existing conditions may arrest the growth of evils but cannot cure them. At the same time no plan can be complete which does not contain practical proposals for dealing with the problems of areas that are already built upon. The planning of areas that are still unbuilt upon or are developed with temporary structures, although presenting the greater opportunities for securing improvements, cannot be sufficient to meet the needs of an increasing population because the major part of their economic activities will continue to center in the heart of the Region with its built-up conditions. Moreover built-up areas as well as open areas are undergoing constant change of use, and reconstruction in the former proceeds almost as rapidly as new construction in the latter. Even if a perfect development of all vacant land could be achieved in a city, as the result of a plan, it would provide only a partial improvement of its living and working conditions so long as the principal business centers and central residence sections were allowed to expand their building bulks without a guiding plan.

Nevertheless it remains true that the full benefits of planning can be obtained only in those areas where it is possible to prevent the beginning of bad conditions. This is true not only because it is easier to prevent than to cure, but also because it is easier to impose restraints in advance against something being done that will be injurious to the community than it is to get rid of the injury after it is done. Misplanning of vacant land is a primary cause of the evils of congestion and indiscriminate building which make later planning and zoning so ineffective.

Functions—It is more difficult to define the limits of a plan from the point of view of the engineering, architectural, economic and social functions than from that of its geographical extent. The human mind inclines to go from one extreme to another. The belief that planning in the past has been carried out with too narrow a conception of what needs to be planned has driven many to the assumption that there can be no limit to the civic problems that should be dealt with in a plan. If, however, a plan were to deal with all physical, economic and social features of the city, it would be nothing less than a charter of civilization. It is obvious that by trying to do too much we may accomplish as little as by failing to do enough. The same observations applied to the Regional Survey. Decisions as to what were the most relevant and essential features to be investigated have been an important part of the work of making the survey. The temptation to inquire too much is sometimes based on the temptation to include too much in a plan. Even when it is decided that there must be limits in the field to be dealt with in a plan, it is not easy to determine what are the best limits. Moreover it is not easy to define the limits in terms, even when we have an understanding of what they should be.

"The failure of plans to achieve adequate results in the past," the report states, "has been due largely to lack of comprehensive treatment of the combined problems of circulation, utilization of land and building development, for an area large enough to enable problems of urban growth to be understood in proper perspective and in their full significance and relations."

The boundaries of the region to be dealt with are largely determined on three grounds: "(1) They embrace the area within which the population can and does travel in a reasonable time from home to place of work—that is, the commuting area; (2) they follow the boundaries of cities and counties at the periphery of the commuting areas in order to relate the plan to the areas of administration; and (3) they have regard to the physical characteristics, such as watersheds and waterways." Excluded from the studies and resulting plans were local or city and village planning in general, as well as planning for water supply and sewerage and regulation of traffic, but consideration was given to the broader aspects of these subjects as related to regional planning.

Under centralization and decentralization, the report urges that "all community groupings are centered and all urban growth a form of centralization" and that "therefore the use of the term 'decentralization' is a misnomer unless the intent behind its use is entirely to break up compact communities however well planned and arranged." What appears to be wanted, the report says, is:

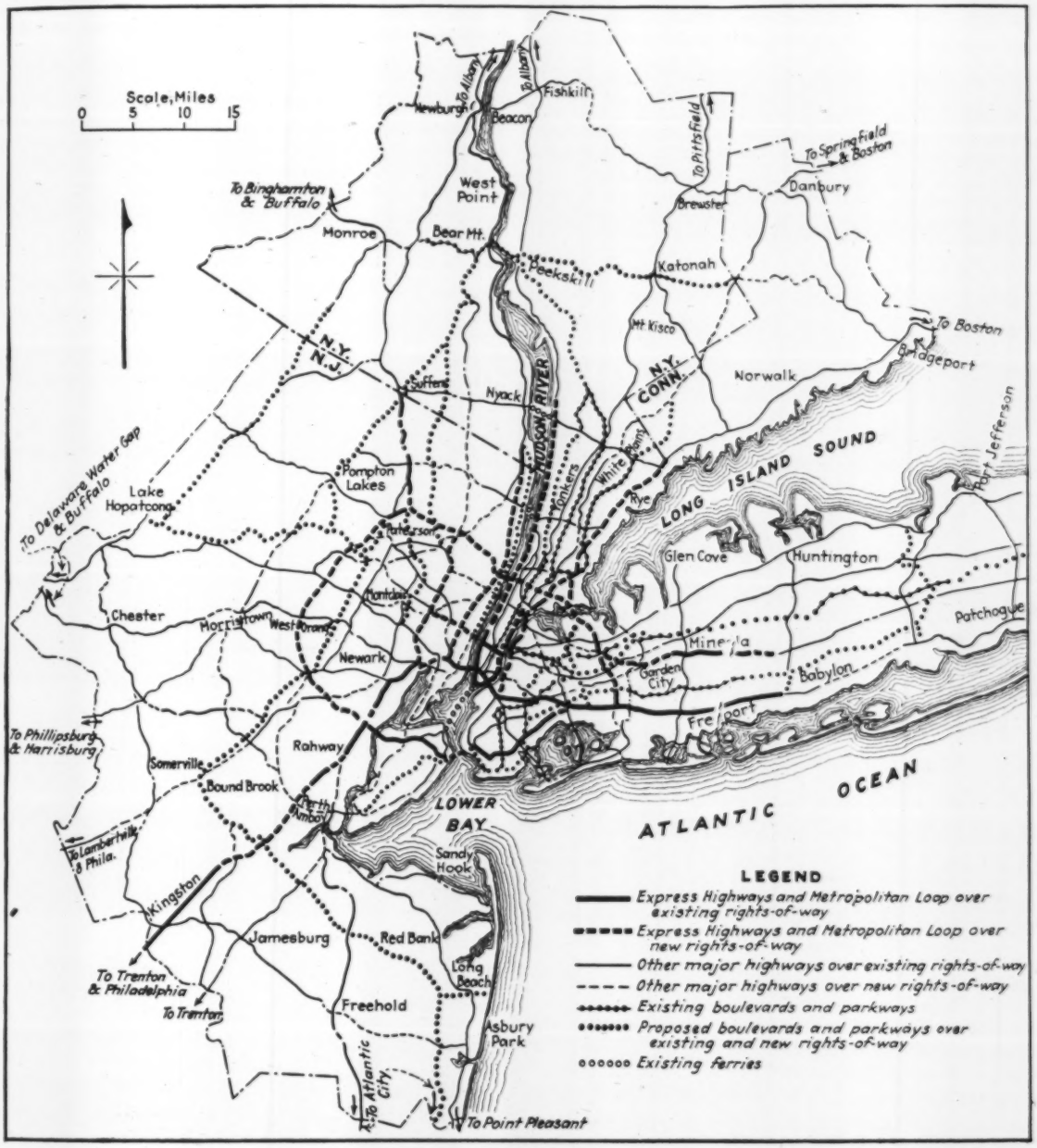
EXPRESS HIGHWAY SYSTEM

Diffused re-centralization of industries with an object of lessening the density of congested centers and of creating new centers; (2) diffusion of residents into compact residential neighborhoods throughout the whole urban region, integrated with the industrial section so as to reduce distances between homes and places of work;

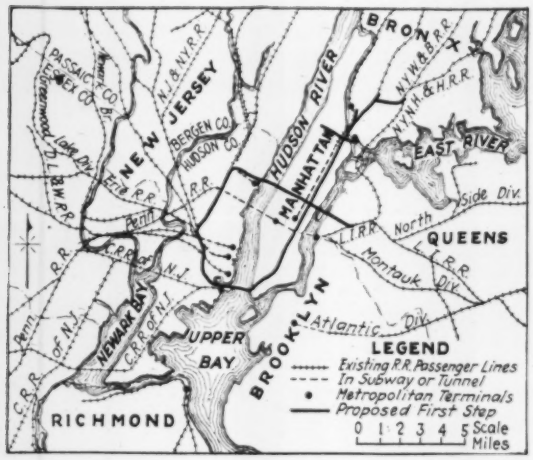
(3) sub-centralization of business so arranged as to provide the maximum of convenience to residents.

Major Highways—Three general maps, supplemented by numerous more detailed maps for different sections, show major highway routes. Of those here reproduced, one is a diagrammatic scheme, another is a general plan and a third shows an express highway system. A "very large percentage of the routes," the report states, "follow existing highways," some of which "are already improved as major highways," while others "are as yet unpaved." The proposed major regional routes, it is expected, "would correspond largely with the state highway systems as such are projected at the present time." The proposed "express highways should be free from grade intersections at all important intersecting highways." The minor regional routes correspond largely with the present county highway system, but would also include some supplementary routes which might be considered as part of the state highway systems.

The proposed metropolitan loop encircles the main centers of business and commerce "and surrounds most of the intensely developed residential areas." Its average "course lies about 12 miles" from the New York City Hall. Proposed "inner routes" are major regional routes within the metropolitan loop. They run approximately east and west and north and south. There are also 20 radial routes. These "have been numbered in a counter-clockwise direction," No. 1 being on the southerly shore of Long Island and No. 20 near the Atlantic Coast in Monmouth County. Supplementing the metropolitan loop are "outer circumferential routes." These are described in a clockwise direction, starting on the Atlantic



GENERAL PLAN OF HIGHWAY SYSTEM FOR NEW YORK AND ITS ENVIRONS



FIRST STEP IN SUBURBAN RAPID TRANSIT

Coast. Finally, but not least in importance, is the proposed "metropolitan by-pass."

Express Highways—Illustrating what is meant by express highways, citation is made of the New Jersey highway route No. 25 between Elizabeth and the New Jersey approach to the Holland Tunnel under the Hudson River; also to the elevated highway along the west waterfront of Manhattan between Canal and 72d St. (construction of which has been officially started since the report was written).

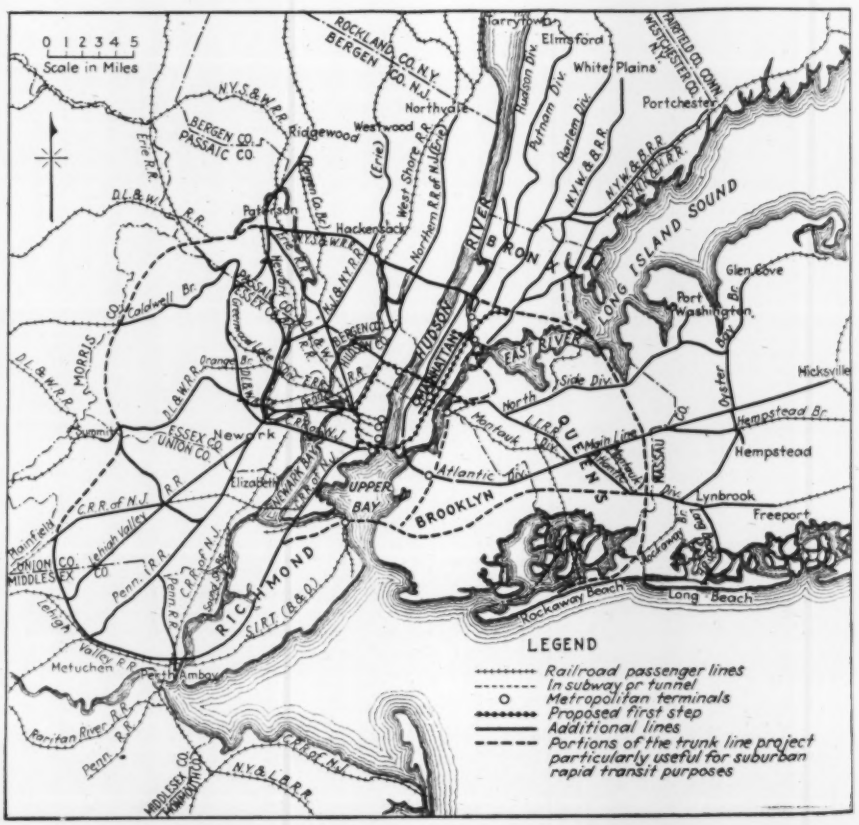
Parkways and Boulevards—A plan in the report (not here reproduced) shows proposed parkways and boulevards. The report states that the region already "possesses a fairly complete system of such highways and that the most extensive program of highway improvement that needs to be carried out is to widen and straighten these and to eliminate bad grades."

To meet the cost of the proposed system of highways, including parkways and boulevards, is a problem considered briefly in the report. Construction must be carried out co-operatively by state, county and municipalities and must extend over a considerable period of years. The highway system, as well as the proposed railways, "should be made as self-sustaining or revenue-producing as possible." This does not mean toll charges on the highways except in "special cases of bridge and tunnel connections." Assessments on property benefited by highways and indirect charges on motor vehicles are assumed as the main sources of raising of money for the highway system. The report suggests that "the time may come when more of the cost of those highways for the use of which no toll can be levied will have to be paid for by higher taxes on vehicles." Besides assessments for benefits and indirect taxes on motor vehicles, an improved highway system will increase the value of land subjected to general taxation, thus providing funds which may be drawn upon for highway improvement.

Suburban Rapid Transit—A comprehensive rapid transit system is presented in the report. Suburban rapid transit systems serve commuters and are "run upon a time-table" schedule while a city transit system runs on a "time-interval schedule." At present the suburban rapid transit is afforded "entirely by the trunk line railroads on reduced-fare tickets." This commuting traffic "has been increasing at rapid rates and now presents so serious a problem for the railroads that it is generally admitted

COMMUTING TRAFFIC IN AND OUT OF NEW YORK CITY IN 1924 WITH ESTIMATES FOR 1965

From the north:	Total In- and Out-bound	Average Daily One-way	Per centage	Total In- and Out-bound	Average Daily One-way	Per-centage
	Actual Figures for Year 1924			Estimates for Year 1965		
Grand Central and all Bronx terminals	29,647,000	46,300	18.2	50,500,000	78,800	18.6
From the east: Long Island terminals and Pennsylvania station	40,300,000	63,000	24.9	98,000,000	153,000	36.1
From the west: All Manhattan and New Jersey terminals of New Jersey railroads	92,053,000	144,000	56.9	123,000,000	192,000	45.3
	162,000,000	253,500	100.0	271,500,000	424,000	100.0

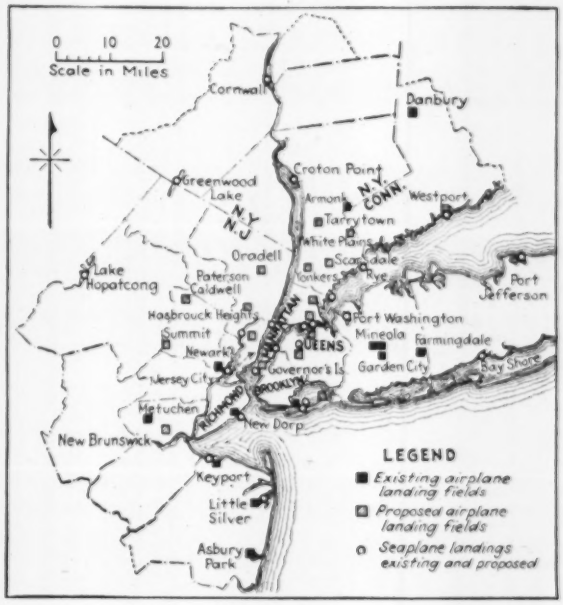


ULTIMATE PLAN FOR SUBURBAN RAPID TRANSIT

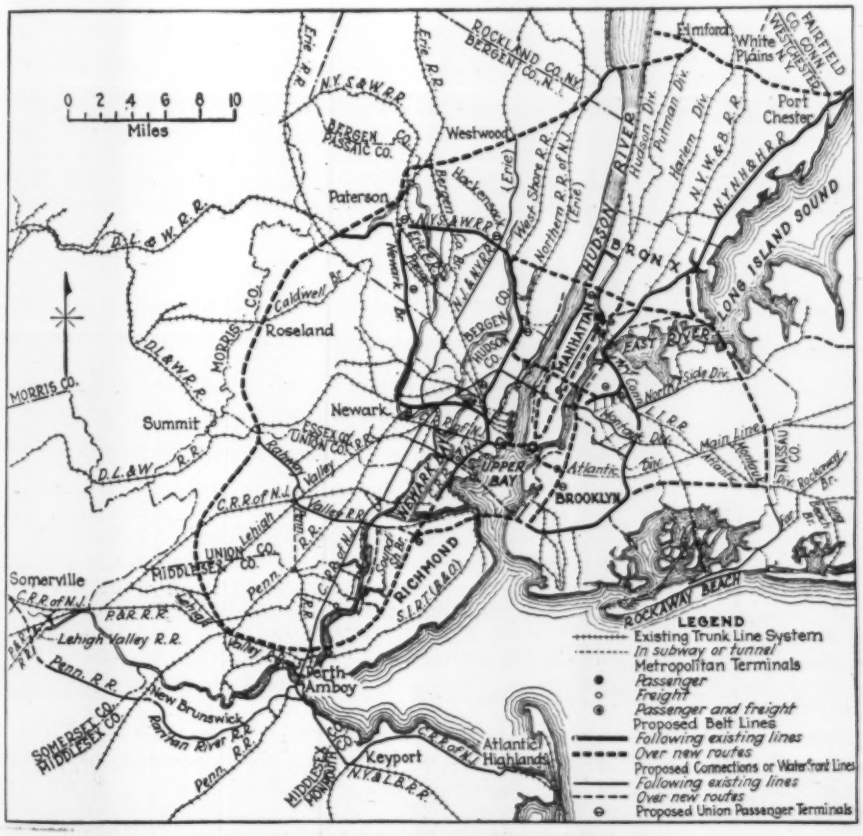
that special facilities for it must be created within the central part of the region." Quoting again from the report: "If the special suburban rapid transit facilities proposed within the area are carried out the railroad lines * * * * would be enabled to deal adequately with the needs of long distance travel, which was originally their primary function." The commuter traffic to and from New York City in 1924 and the estimated traffic for 1965 is summarized in the accompanying table.

It will be seen that the commuter traffic from New Jersey was 56.9 per cent of the total in 1924 and is estimated at 45.3 per cent in 1925. At present "commuters from New Jersey are subject to great inconvenience and delay after arriving at" their respective railway terminals. From these points "many take additional means of transportation to arrive at their destinations," including, in some cases, either ferry or tube to get from the New Jersey to the New York shore and in addition one or more means of transportation, with additional fares, to get to their destinations. In contrast: "The ideal suburban rapid transit system should transport the commuter from his place of residence to within reasonable walking distance of his destination, or at least minimize the necessity for changing from one form of transportation to another." In addition to this, passage between "various suburban parts of the region" should be provided "with the least possible inconvenience." The system outlined in the report is designed to meet the two broad general classes of wants—to and from the suburbs of New York and between the outlying suburbs within commuting distance.

The suburban rapid transit plan has been drawn in relation to (1) the proposed trunk line railroad system; (2) the city rapid transit system; (3) the future subcenters of population; (4) the proposed highway system; (5) the best utilization of land within the region. The first step proposed "is in general merely the co-ordination of proposals already made by agencies representing different parts of the region." The ultimate system is planned to "provide for the estimated future traffic" (see table).



AIRPORT SYSTEM PLAN FOR NEW YORK REGION



TRUNK LINE RAILROADS AND TERMINALS IN NEW YORK REGIONAL PLAN

The outstanding feature of the "first step" is "a loop between Manhattan and New Jersey, connected on the north with the New York Central, the New York, New Haven & Hartford, and the New York, Westchester & Boston Railroad; and connected on the east with the Long Island Railroad in Queens." Also, "an extension of the New York, Westchester & Boston Railroad from its southerly terminus in the Bronx to and across Manhattan in the neighborhood of 125th St." to be connected later "with a route on the west side of Manhattan included in the ultimate plan."

The ultimate plan presupposes "the electrification of most of the railroads handling commuter traffic or the substitution of additional trackage for electrical operation, either under, over, or adjacent to the existing railroad rights-of-way. In New Jersey it would include an area within a radius of about 20 miles from the New York

City Hall and in Westchester and Nassau Counties in New York an area within a 25 mile radius from the City Hall.

Trunk Line Railroad Systems—As already stated, the proposed rapid transit system was to afford relief to the trunk-line railroads now burdened with commuter traffic. The trunk-line system looks forward to providing passenger and freight service into and out from New York for a population of 20,000,000 in 1965. The 1923 freight tonnage both ways, excluding interchange, was 69,000,000 tons and the 1965 estimate is around 100,000,000 tons or a 45 per cent increase. Trunk line passengers in and out of New York metropolitan terminals in 1924 totaled about 243,000,000, including commuters. Deducting the latter "whom it is proposed to serve primarily by special suburban rapid transit systems, this leaves about 81,000,000 other railroad passengers for the year 1924. It is estimated that by 1965 the trunk-line railroad traffic will be 270,000,000 passengers a year, about 3.3 times the 1924 figure. This is only some 11 per cent in excess of 1924 total of passengers carried including the commuters.

The proposed trunk-line railroad system includes both inner, outer and connecting belt lines with waterfront connections. The purpose of the outer belt line is to insure industrial development outside the central congested area and to permit both through and interchange railroad traffic to by-pass the central part of the region. This line is mostly over new right-of-way, and primarily through open and undeveloped country encircling the region at a distance of about 20 miles from New York City Hall. Connections would be made with all intersecting railroads and the port of New York "would be brought into direct contact with every harbor and industrial development." There would be "a system of three inter-connected inner belt lines, one in New Jersey and two within the limits of New York City, all joined together by three Hudson River crossings and other connections."

Union Passenger Terminals—Of 13 proposed union passenger terminals, six would be on the New Jersey inner belt line, at Paterson, Hackensack, North Bergen, Jersey City, Newark and in Clinton, southwest of Passaic. In Manhattan there would be three of these stations, including the present Pennsylvania and Grand Central terminals, with an additional terminal "in the neighborhood of 178th St. and Amsterdam Ave. on the outer belt line." Each of the four other boroughs of New York besides Manhattan would have a terminal. Motor bus terminal stations in line with those already established in Manhattan by the Baltimore & Ohio Railroad are proposed but not gone into in detail.

Waterway Systems—In view of agencies already developing the Port of New York, the report does not go much into waterways facilities there. Attention is given to the New Jersey ship canal, between Raritan Bay and the Delaware River "sponsored by the state of New Jersey to form part of the intra-coastal canal projected by the Unted States Government along the Atlantic Coast." This route, which will be 33.7 miles long, "would reduce the distance by water from New York to Philadelphia from 274 miles to 87 miles. The recently enlarged Delaware and Chesapeake Canal, which is the sea-level link of the inter-coastal canal across the state of Delaware, reaches the port of Baltimore. Straightening of the Hackensack and Raritan Rivers is briefly outlined in the report.

Airplane Landing Fields—Of the 1,330 airports in the United States included in the list issued by the Aeronautic Branch of the Department of Commerce in January, 1929, 22 were in the New York region. Suggestions for increasing the latter number to 46, as shown by the accompanying map, are included in the report.

Land Uses and Zoning—A considerable portion of the regional report just issued is devoted to uses to which the land of the region can best be put, taking into account existing and desirable future conditions and correlating existing and possible future zoning regulations with the various ways and means of communication, the topography of the country and a variety of other governing conditions. "Within a 20 mile radius there are two definite classes of areas," the report states, "one of which consists of land already more or less intensely built upon, and the other of partly developed suburban land with a high value for prospective building uses. Outside the 20-mile radius the building growth has taken place mostly in spots where comparatively small cities and villages have become established, and the greater part of the open land beyond the fringes of the small urban centers is still in primary use for agriculture or forest and of little or no building value." Inside the 20-mile radius, there are two zones—"an inner including New York City, Hudson County and the city of Newark, having an area of 325 sq. miles; and surrounding this the suburban zone of 536 sq. miles. Beyond the limit of the 20-mile radius there are 4,627 sq. miles of territory and for this area "less ample proposals are made than for the inner zone."

Lightweight Material for Concrete to Be Tested by Bureau of Standards

Methods of production of lightweight aggregates for concrete will be studied in research undertaken by the Bureau of Mines, the Department of Commerce announces.

The decrease in dead weight resulting from the use of these materials effects a considerable saving in the cost of constructing large buildings, bridges, etc., it was pointed out in the statement, which follows:

Methods for the production of lightweight aggregates for concrete have been the subject of numerous patents since 1867. It is, however, only recently that the industrial importance of such materials has been fully appreciated. Low-grade clays, shales, and shale rock when heated rapidly at about 2,000 deg. F. for a short period of time expand to 2½ to 3 times their original volume.

Material sintered in this fashion when subsequently crushed and used as concrete aggregate yields concrete of the same or somewhat larger compressive strength and of only two-thirds the weight of concrete made with ordinary rock and sand aggregate. The decrease in dead weight resulting from the use of these materials effects a considerable saving in the cost of structural steel for large buildings, bridges, etc.

In view of the importance of this new industry as evidenced by the number of inquiries concerning the deposits of clays and shale available for the manufacture of lightweight concrete aggregate, the Non-Metallic Minerals Experiment Station of the Bureau of Mines, in co-operation with Ceramics Department of Rutgers University at New Brunswick, N. J., is planning to start a survey of such deposits and a laboratory investigation of the fundamental factors involved in the manufacture of these aggregates.

Setting Temperatures in Concrete Bridge Piers

Tests of Heat Changes in Mass Concrete and in Inclosure Show Setting Temperatures Fluctuating With Outside Cold

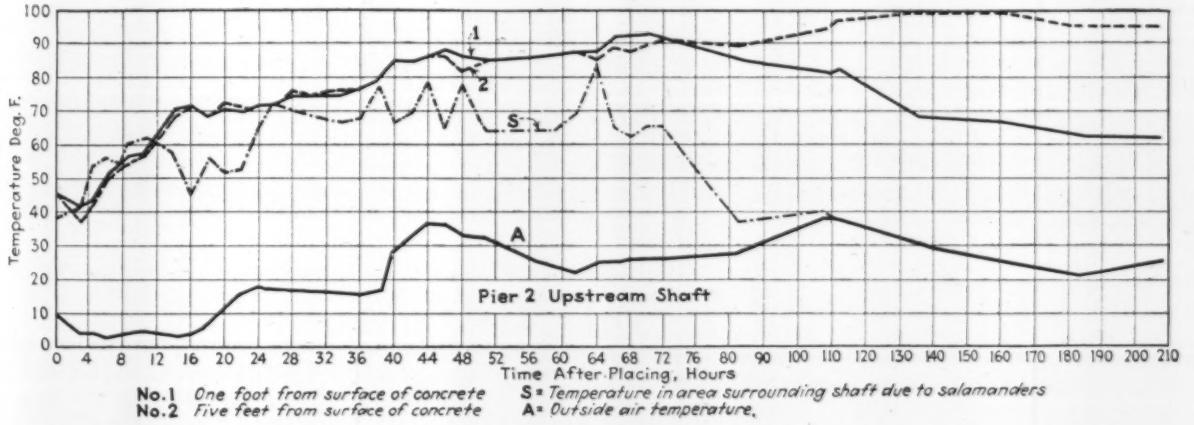
By A. A. Jakkula
Instructor in Civil Engineering, University of Michigan, Ann Arbor, Mich.

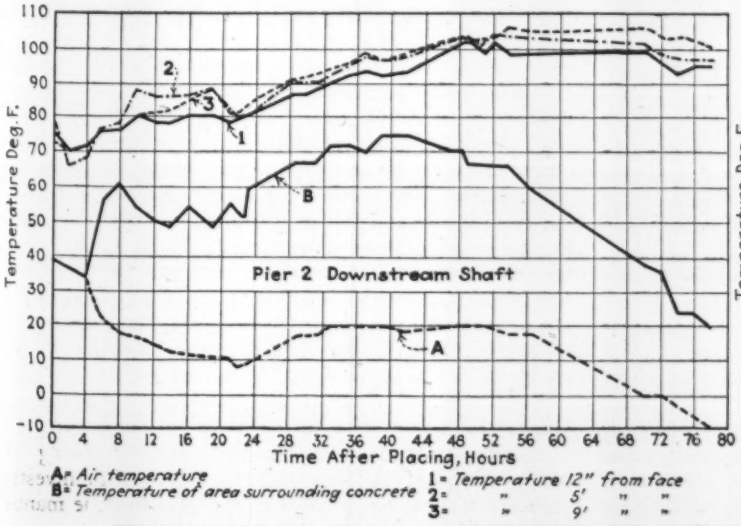
When Portland cement concrete is placed while the air temperature is below the freezing point of water, it is necessary to protect it during the setting period. This article gives information on the efficiency of protecting concrete by tarpaulins and salamanders and also information of the temperatures reached by setting concrete. The studies were made during the winter of 1926-27 on the piers of the Cedar Ave. bridge, Minneapolis, Minn. through the courtesy of F. T. Paul, superintendent of construction. This structure is reinforced concrete with an overall length of 2,951 ft. It consists of seven arches, five with spans of 93 ft. and two with spans of 265.5 ft. The level of the bridge floor at the center is 110 ft. above high water and the rise of the main spans is 92 ft.

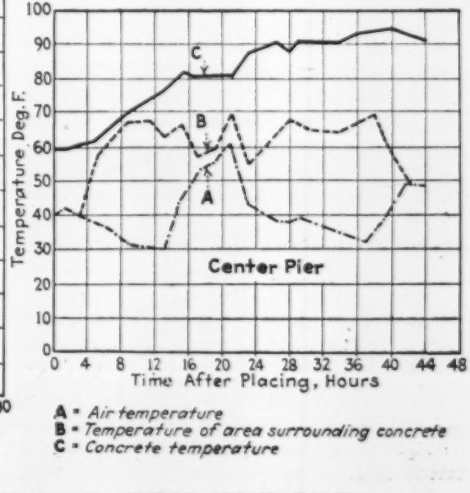
Thermocouples were used for measuring the temperature of the concrete and thermometers for measuring the outside air temperature and the temperature in the area surrounding the forms. The concrete in the sections upon which tests were run was made of Portland cement, trap rock and washed sand. The water-cement ratio was always 0.90. The average fineness moduli of the sand, trap rock and mix were 2.60, 7.80 and 5.6, respectively. The average real mix was 1:5:3 and the average field mix was 1:2.86:4.62. These figures while averages, give very closely the mix used in the sections investigated. An inundator was used to measure the quantity of sand and to eliminate bulking.

When the pour was started, a hole was drilled through the 2-in. form at the desired point. When the concrete reached the level of the hole, the pipe was inserted and concrete tamped around the pipe to hold it in position. Care was taken to see that the thermocouple itself was in the concrete and not in a water or air pocket. Then the wires were connected to the switch and readings were started.

Readings were taken in the lower portion of the center pier and in the lower portion of the two shafts of one of the shore piers referred to as Pier 2. The section of the center pier in which temperatures were taken was roughly 8 ft. high, 50 ft. long and 25 ft. wide, rectangular with pointed ends. This pour contained 415 cu.yd. The thermocouples were placed 4 ft. from the bottom and perpendicular to the center of the 50-ft.


Temperature Deg. F.
Time After Placing, Hours
Pier 2 Upstream Shaft
No.1 One foot from surface of concrete
No.2 Five feet from surface of concrete
S = Temperature in area surrounding shaft due to salamanders
A = Outside air temperature.


Temperature Deg. F.
Time After Placing, Hours
Pier 2 Downstream Shaft
A = Air temperature
B = Temperature of area surrounding concrete
1 = Temperature 12" from face
2 = " 5' " "
3 = " 9' " "


Temperature Deg. F.
Time After Placing, Hours
Center Pier
A = Air temperature
B = Temperature of area surrounding concrete
C = Concrete temperature

TEMPERATURE CHANGES IN CONCRETE PIERS FOR THE CEDAR AVE. BRIDGE, MINNEAPOLIS

side. They were set in 8.5 ft., 12.5 ft. and 16.5 ft. In the graph all three readings were averaged, since all were nearly identical.

The sections of the two shafts on the shore pier were 16 ft. high, 14 ft. wide and 15 ft. long. The pours consisted of 122 cu.yd. each. The thermocouples were placed 3 ft. from the bottom and perpendicular to the center of the 15-ft. side at distances 1 ft., 5 ft. and 9 ft. from the surface. When the readings on the upstream shaft were started the couple farthest in failed to register, so the test was continued with only two couples. All pouring was continuous at a rate of slightly over 20 cu.yd. an hour. Before any pouring was started the forms were thoroughly dried and warmed by salamanders. The sand, trap rock and water were heated by means of steam pipes.

When each pour was finished, the entire section was covered with a tent-like arrangement of tarpaulins within which were placed salamanders heated with charcoal. The salamanders were placed around the sides and on top. On the upstream shaft of pier 2 eight were used; on the downstream shaft of the same pier six were used and on the center pier twelve were used, but were all placed on top. Heating at the center pier was continued for 33 hours, on the downstream shaft of pier 2 for 54 hours and on the upstream shaft for 72 hours.

From the graphs the following facts are evident:

(1) The temperature in the concrete fluctuates with the surrounding temperature if allowance is made for lag, but is increasing due to the heat generated by its own chemical action.

(2) The concrete nearest the surface is most susceptible to the outside temperature.

(3) A rise of from 30 to 50 deg. can be expected in large masses of concrete if suitably protected, and

(4) Canvas and salamander protection is satisfactory.

Electric Traffic Counter Operated by Shadows

An experimental electric traffic counting apparatus has been installed at one end of the Holland tunnel, which registers the passing of all vehicles on a dial in the administration building of the tunnel commission some distance away. The apparatus, which has been installed by the General Electric Company, consists of a small floodlight mounted in an inclined position upon the overhead ironwork of the tunnel, its beam of light falling upon a little circular window in a box placed beneath the sidewalk at the opposite side of the roadway. The box contains a photo-electric tube, an amplifying tube and an electrical relay. Each time a vehicle passes the spot, the beam of light falling upon the photo-electric tube is interrupted and a slight electrical impulse is created. This is amplified by the vacuum tube and fed to the relay, which energizes a transmission circuit, the other end of which is in the administration building. There a registering dial is actuated by the electric current so that it turns, registering one more figure, in response to each impulse from the relay. It is hoped that by installing several of these photo-electric tubes in different sections of the tunnel it may be possible to tell in the administration building the exact number of vehicles in any part of the tunnel. Such information would be of unusual value in case of a tie-up in the tube, since the amount of air supplied must be governed by the number of vehicles in any specific section of the tube during the time of the delay.

Mechanical Equipment of Office and Newspaper Building

Ink and Oil Distribution—Ventilation of Track Space—Heating and Plumbing for 26-Story Structure

MUCH special equipment had to be provided in the new 26-story Daily News Building, Chicago, to meet the requirements of newspaper work and the problem of ventilating the space beneath the ground floor of this building, which is erected over the north approach to the Chicago Union Station. Some of these features are noted in the following description, condensed from a paper read before the Western Society of Engineers by G. C. Burge, assistant mechanical engineer for Holabird & Root, architects for the building.

Steam Heating—The heating and steam system is simplified by the purchase of steam from the Union Station Company. The steam services consist of a large and small steam line and a large and small return, the small lines only being used during the summer. Steam is required for general heat, ventilation and the kitchen, and for a few miscellaneous purposes. Reducing valves with distribution mains serve the entire building at the required steam pressures.

In general, the heating system consists of direct cast-iron radiation with distribution piping for a two-pipe vacuum system for the entire building. A portion of the press-room space is provided with temperature control, and all air supply for ventilation has automatic temperature control. The system is arranged for up-feed from distribution mains on the basement ceiling to serve the lower seven floors. For the eighth to the 23rd floor, inclusive, there is a down-feed system from distribution mains in a pipe space above the 23rd floor. The 24th to 26th floors are served by up-feed from a separate set of mains in this pipe space.

For economy in operation, air-actuated valves are provided on the branches in the distribution mains, each valve being arranged to control a certain section of the system, so that heating can be controlled from the pump room. Heating coils for the air-supply system are served with low-pressure steam and have automatic temperature control. Water heaters are heated with low-pressure steam and so arranged that the balance can be shut off and steam applied to the heaters only. A separate system of steam at 35 lb. is provided to the kitchen and the cafeteria. Kitchen equipment in general is heated by high-pressure steam.

Printing Ink Supply—An unusual feature is the requirement for ink storage and distribution for the newspaper plant. Three 2,500-gal. storage tanks will receive ink from trucks and deliver it through distribution piping to the presses by means of pneumatic pressure. This piping is arranged so that one tank can be filled with special ink for experimental purposes, thus enabling the use of standard ink on all but one press, and the testing of another ink without impairing the efficiency of the plant.

Kerosene and Benzine Supply—As the newspaper plant requires kerosene for cleaning purposes, two storage tanks of 250-gal. capacity each, on the ground floor, can be filled by truck delivery. Piping will deliver kerosene to the press-room floors at various outlets by means of pneumatic pressure on the tanks. For benzine, which

is required in the composing room, a 300-gal. storage tank is provided under the basement floor to be filled from tank wagons in the street. It will be delivered from this tank to the fifth floor through a hand-operated high-lift pump.

Compressed Air Supply—This is required throughout the newspaper plant for cleaning, and also throughout the various fan rooms, elevator machine rooms and at miscellaneous points for cleaning machinery. A system of piping is provided, with outlets at the various machines and in the various rooms, so that not more than 50 ft. of hose will be required to reach any desired point.

Ventilation—To dispose of the smoke from the locomotives below the concrete deck of the plaza, a smoke chamber is arranged to receive the smoke, allow the necessary room for its expansion and discharge it through a duct to a natural-draft stack extending to the top of the building. This stack is so arranged that apparatus for positive exhaust of the air and smoke from the smoke chamber can be installed. Over the center of each track is a slot opening into the smoke chamber. For certain portions of this chamber, which are so located that it is not possible to connect them to the main stack, motor-driven fans will draw off the smoke and deliver it to a separate stack leading through the roof.

Besides a general ventilating system for the building, special ventilation is necessary in the newspaper departments. Air supply and exhaust are to be provided in the sub-basement, basement, stores, press rooms, newspaper machinery rooms and other principal workrooms; also in the cafeteria and kitchen. Special exhaust fans are to be provided for lead pots, for the engraving department and for special rooms for processes used in newspaper work. All fan systems consist of motor-driven multi-vane fans with galvanized steel ducts to distribute the air to the various spaces. Air supply systems have automatic self-cleaning air filters with the necessary heating coils.

The air-supply system for the building consists of fifteen different units with a total capacity of 210,000 and a maximum capacity of 275,000 cu.ft. per minute. The exhaust system is to have a normal and maximum capacity of 200,000 and 270,000 cu.ft. per minute. For the driveway, there is a separate exhaust system of 70,000 and 100,000 cu.ft. per minute normal and maximum capacity.

Plumbing—Besides an automatic motor-driven fire pump of 1,000 g.p.m., standpipes are provided throughout the building, with valves and hose, so that any part can be served with hose not more than 75 ft. long. This fire system is provided with the necessary fire hydrants and siamese and fire-boat connections. A part of the space in the basement and sub-basement, which has the maximum fire risk, has an automatic wet-pipe sprinkler system.

Roof drainage is discharged directly into the city sewers, but a special drainage system for the plaza is arranged to empty into the river. The sanitary system serves all toilet rooms and fixtures, and is to drain by gravity into the city sewers. All sanitary and other drainage below the first floor will empty into ejectors discharging into the sewers.

Water Service—One system of the compression type is provided for the lower portion occupied by the *Daily News*, and another of the straight gravity type for the remainder of the building. Two automatic motor-driven pumps serve the house tanks on the 26th floor and three automatic house pumps serve the compression system.

In the newspaper plant there is a special problem to provide cooling water for casting, linotype and other machines, and these are served from the compression water system. As the general and cooling load for the lower portion of the building is subject to considerable variation, the house pumps for this section are of 250 to 450 and 750 gal. capacity respectively, allowing a variation in capacity suitable to care for the loads anticipated. Cooling water from the newspaper plant, which passes through jackets and is clean, is returned to a concrete surge tank of 40,000-gal. capacity and cooled by a spray in the tank. A fan draws air over this tank to assist in the cooling. The house pumps draw from this tank, and its water level is maintained by the city mains through both an automatic float valve and a temperature control valve designed to keep the temperature of the water down to an allowable limit.

Hot water for the building is provided from the house tanks by heaters of the storage type. An extra feature is provided in economizers, through which the condensate from the heating and steam systems is passed before being returned to the Union Station Company's plant.

Reconditioning Roads

By Chas. R. Waters
District Engineer, New York Department of Public Works, Buffalo

The Following Extract from a discussion presented at the last annual convention of the State Highway Officials of the North Atlantic States contains a statement on resurfacing experience on approximately a thousand miles of paved road in charge of the author.
—Editor.

Out of 1,025 miles of pavement under maintenance by the state in my district, 532 miles are of concrete and 160 miles have been surface-treated or reconstructed. About 70 per cent of these concrete pavements are more than seven or eight years old and have received a light or heavy surface treatment or else have been resurfaced or reconstructed. We paint with bituminous material the small scaled areas as they develop. As scaling progresses we apply a light surface treatment; we prefer tar for the first priming coat. Where the travel is heavy we apply a surface treatment as soon as possible, building a mat about 1 in. thick. When this heavy treatment cannot be economically maintained we resurface, either with new concrete or with one of the various bituminous tops.

My general reaction to the bituminous surfacing of concrete is that a thin cover is of assistance in delaying the disintegration that is taking place, but it is not the real solution. Thick cold-patch tops, 2½ to 3 in. thick, Amiesite, Tarvia-Lithic of the same thickness, and hot-mixed tops, either sheet asphalt or Topeka, seem to be the most effective for maintaining a satisfactory and adequate surface in those cases where the reconstruction work has not been delayed so long that the value of the old concrete as a base has been lost. Some of the old concrete roads were even less than 5 in. thick on the edges when originally built, and it is doubtful if they were ever thick enough even in their original state to support a bituminous top. In these cases reconstruction with concrete is probably advisable.

Failure of Hackensack Bascule Bridge Found Due to Inadequate Design

Final Report of Board of Engineers Locates Initial Failure in Counterweight Tower and Reveals Existence of Greatly Excessive Stresses in Tower Legs—Bearing Friction Not a Contributing Factor

COLLAPSE of the east leaf of the Hackensack River bascule bridge on the Lincoln Highway, near Jersey City, N. J., on Dec. 15 last, was caused by excessive stresses in the counterweight tower, according to the final report of the board of investigating engineers. The report, rendered on May 11, is summarized in two main conclusions:

(1) The failure of the bridge occurred through the fracture of the north leg of the east counterweight tower; this fracture had been progressive for some time in the past.

(2) The cause of the failure was the inadequacy of the design of the counterweight tower to withstand stresses readily calculable from forces known to exist during the normal operation of the bridge.

The board was composed of O. E. Hovey, Prof. George E. Beggs, and D. B. Steinman. It was appointed by W. G. Sloan, state highway engineer of New Jersey, immediately after the accident, and rendered a preliminary report on Dec. 22, which was abstracted in *Engineering News-Record* of Jan. 10, 1929, p. 74. A description of the accident and a preliminary report on the stresses may be found in that article and in the preceding news report, published Dec. 20, 1928, p. 931. The present final report is in general agreement with the preliminary report as to location and nature of the failure, but it is based on much more extended study of the actions involved, including stress measurements on the uninjured west leaf, thorough review and test of the electrical and mechanical equipment of this leaf, and analyses of the various kinds of stress that might be set up in the structure and machinery during operation.

The Bridge and Its Failure

The bridge consisted of two leaves 98 ft. long from trunnion to outer end and about 48 ft. wide between trusses, counterweighted through a balanced and articulated parallelogram over the tail of each leaf as diagrammatically shown in the accompanying sketch. It was designed by the Strauss Engineering Company of Chicago, was fabricated by the American Bridge Company, and was erected under the supervision of the State Highway Department by the Stillman-Delehanty-Ferris Company of Jersey City. At the time of the failure it had been in operation about a year, having being built to replace a swing bridge destroyed by a colliding steamer (*Engineering News-Record*, June 22, 1922, p. 1095).

On the night of Dec. 15, 1928, the bascule had been opened to pass a vessel, and while the east leaf was being lowered it suddenly fell forward into the river, together with the counterweight. The south counterweight tower of the east leaf was bent over sharply at its base, trailing thence forward and downward to the water; the north tower was broken off near its base, the east channel showing a partly rusted tension break and the west channel a bending and tensile break, while the tower itelf had gone forward into the water with the counterweight and span. The west bascule leaf remained standing in fully open position.

The final report, declaring the breaks in the north counterweight tower to be the point of origin of the collapse, states that examination of the failed structure and of members salvaged from the river revealed no indications of failure originating elsewhere than in the counterweight tower. But it reasserts what was brought out in the preliminary report, namely, that the counterweight trunnion posts, which were heavy latticed members, were near failure through buckling of their latticing and batten plates. One batten plate of the trunnion posts of the west leaf showed a dishing of $\frac{3}{4}\frac{1}{2}$ in., and the lattice bars were buckled as much as 1 in. from their original plane.

Deflections of Counterweight Tower—The board reports that while operating the west leaf of the bascule at about one-third normal operating speed, using the auxiliary gasoline engine, it observed large oscillatory deflections of the top of the tower forward and back, with a period of 4.13 sec. and a maximum amplitude of 0.48 ft., as measured by a large number of transit observations. Some 600 extensometer readings were taken on the channels of the tower near their base during the operation of the leaf, and these indicated a maximum variation of stress of 25,500 lb. per square inch, which proved to be reasonably consistent with the observed deflections.

Stresses in the Structure

From study of the calculated stresses in the various parts of the bridge the board finds that:

The critical stresses occur at the base of the counterweight tower (as designed), and these stresses are a maximum when the moving leaf is reaching its highest position at the end of the opening operation. At that position the counterweight is moving in a very nearly horizontal direction, which imposes the maximum possible inertia forces on the counterweight tower due to deceleration of the counterweight as brakes are applied. When the leaf is at or near its highest position, assumed in the design and in our computations at an angle of 86 deg. above the horizontal, any horizontal force acting on the counterweight produces a proportional horizontal component in the top link and a simultaneous vertical component amounting to 3.4 times the horizontal component, due to the obliquity of this link. The connection details are such that this vertical component acts with an eccentricity of 27 in. from the center of the counterweight tower leg.

For the just stated position of the leaf and counterweight, the board computes the separate items of stress action affecting the counterweight tower as follows:

(a) The deceleration due to application of the motor brakes (service brakes) at the specified setting of 250 lb.-ft. torque at motor shaft per brake is 0.700 ft./sec.^{2} at the counterweight trunnion, causing a maximum tension of 27,000 lb. per sq.in. of net section at base of counterweight tower channels.

(b) The deceleration due to application of the emer-

gency brakes at their specified setting, which was equivalent to 350 lb.ft. at motor shaft for each of the two brakes, is 0.97 ft./sec.^{2}, causing a maximum tension of 37,600.

(c) Friction in the counterweight trunnion bearings, when taken at the designer's value of 0.18, produces a tension of 9,000 lb. per sq.in., if this friction acted alone, the deceleration of the counterweight would cause an opposing stress of 5,000 lb. per sq.in., leaving a resultant stress of 4,000. The observed value of the friction, however, was only 0.13, which reduces the resultant stress to 2,900.

(d) Wind on the counterweight and tower at 15 lb. per sq.ft., causes a tension of 14,000 lb. per sq.in. and 30-lb. wind a tension of 28,000.

(e) Vibration of the tower as already mentioned produces a tension of 14,100 lb. per sq.in. of net section. With the higher speed of the electric motor drive much larger vibrations and hence larger stresses would probably result, but for the purpose of the report this increase was disregarded.

Combined Stresses

The summation of the several items of stress is given by the board as follows:

(1) Combined effect of emergency brakes, specified friction, 15-lb. wind load and measured elastic vibration, 61,700 lb. per sq.in.

(2) Combined effect of motor brakes, emergency brakes and specified friction, 60,600 lb. per sq.in.

(3) Combined effect of motor brakes, emergency brakes, specified friction and 15-lb. wind load 74,600 lb. per sq.in.

(4) Combined effect of motor brakes, emergency brakes, specified friction and measured elastic vibration, 74,700 lb. per sq.in.

(5) Combined effect of motor brakes, emergency brakes, specified friction, measured elastic vibration and 15-lb. wind load, 88,700 lb. per sq.in.

It should be noted that any one of the foregoing combinations, all of which are possible of occurrence in actual operation, is sufficient to explain the failure as it occurred.

When the additional secondary stresses are included, the five combinations of stress-producing factors listed above will yield maximum fiber stresses at the base of the tower legs ranging from 74,500 to 109,100 lb. per sq.in. of net section, more than sufficient to account for the failure.

It should also be borne in mind that we are here dealing in large part with reversing and repeating stresses, which bring into play an endurance limit below the ultimate strength, which must be still further reduced in view of the notched section at the rivet hole through which the first fracture occurred.

The board points out that under one clause of the Canadian standard specification (1927) for movable bridges of this type, a counterweight tower must be proportioned to resist, in addition to the vertical loads, a 30-lb. wind load, or, as an alternative, a horizontal force equal to 5 per cent of the supported load applied at its center of gravity, whichever demands the greatest section. The 30-lb. wind, as already listed, would produce a stress of 28,000 lb. per square inch of net section at the base of the tower, while a horizontal force amounting to 5 per cent of the supported weight would produce a maximum tension of 64,000. The board remarks that "the requirement of the Canadian specification is not too drastic."

Other Suggested Causes of Failure

In order to consider all possibilities regardless of the evidence of the wreckage and the high stresses just mentioned, the committee also studied other suggested causes of failure. It finds that none of them is adequate. As to pier settlement, surveys showed the piers to be at their correct levels. As to abnormal operation of the bridge at the time, the board states that the bridge was being operated in normal manner by an experienced operator, and the electrical control devices predetermined a safe sequence of operations.

As to eccentricity of the counterweight this was calculated to be only 1½ in., and was toward the land, or in the opposite direction to the failure.

Bearing Friction—Special study was given to the subject of bearing friction in view of a charge that the bearings had been improprly installed and may have seized. The board finds that "high trunnion friction was, at the worst, only a negligible factor in producing the failure."

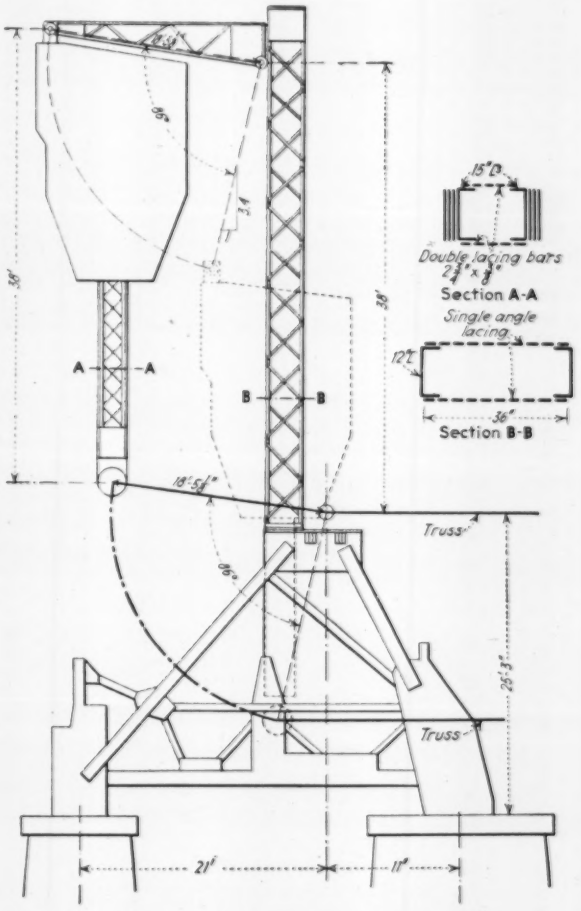


DIAGRAM OF COUNTERWEIGHT SYSTEM OF HACKENSACK RIVER BRIDGE

The bridge had been designed on the assumption of 18 per cent bearing friction in the main and counterweight trunnion bearings, but power measurements showed that the average friction in the trunnion bearings amounted only to 13.3 per cent. It was found that wooden blocks had been left in the ends of the lubrication grooves of the main trunnions but tests showed that they did not interfere with the flow of lubricant, and there were no such blocks in the counterweight trunnion bearings. No evidence was found that lubrication had been neglected, but to check this stress measurements in the counterweight tower legs (of the west leaf) were

made first with the bearings as found and, second, after fresh lubrication of the counterweight trunnion bearings; after a few operations of the leaf with fresh lubrication, the stresses in the tower returned to substantially the same range of magnitude as before.

The material of the bushings of the counterweight trunnion bearings of the east leaf was tested physically and chemically and found satisfactory. Both the physical tests and the chemical composition (Cu 82.25, Sn 16.92, P 0.45, other elements 0.38) satisfied the specification requirements, which were the A.S.T.M. specifications for bronze bearing metals Class B.

Following the board's observation of the dangerous condition of the counterweight posts and the weakness and excessive flexibility of the counterweight tower these members of the uninjured west leaf were strengthened, according to designs prepared by the board, before the west leaf was again put into operation.

Paris Terminal Stations Enlarged for Heavy Traffic

A REVIEW of proposed extensions of the several main-line railway stations at Paris, France, including interesting particulars as to the relations between number of passengers handled and number of platforms is given by Mr. Duchesnoy, in the *Bulletin* of the International Railway Congress. Mr. Duchesnoy states that the present stations have become inadequate owing to a combination of heavy suburban traffic (involving frequent movements of empty trains), extra main-line trains for steamship connections, and heavy traffic to tourist resorts, which last often requires running many trains in separate sections.

To meet the varying conditions of traffic the stations require a number of reserve platforms. As to the suburban traffic, the switching movements of engines and trains would be reduced materially by electrification, the trains then reversing or moving in either direction without the complication of transferring a locomotive from one end to the other. This electrification is being carried out both on suburban lines and several main-line routes. As a basis for comparison between stations, a formula is given for an index number which is obtained by dividing the number of platforms into the number of passengers during the busiest hour of the day. From the figures given the accompanying table has been prepared.

TRAFFIC AT RAILWAY TERMINALS, PARIS, FRANCE

Station	Million Pass. 1927	Max. Pass. per Hour	No. of Platforms	Index Number	No. of Platform Tracks	Max. Trains in One Hour A.M.	Max. Trains in One Hour P.M.
Est Ry	40.0	13,300	18	739	18	19	19
Nord Ry	....	21,500	24	896	19	31	35
Paris-Orleans Ry	9.0	7,000	10	700	10	17	14
Paris, L. & M. Ry	22.8	10,500	12	873	12	14	15
Etat Ry., St. Lazare	72.6	35,000	27	1,300	27	..	35
Etat Ry., Montparnasse	14.0	.....	8	.....	10	..	..

Note—Of the 22,800,000 passengers at the P., L. & M. Ry. station, 15,200,000 were suburban passengers. When the electrification of the suburban lines is completed this summer the maximum hourly traffic at the St. Lazare station is expected to reach 64 in the morning and 57 in the evening (44 being electric trains in each case). The maximum number of trains in one hour is exclusive of switching and empty train movements.

It is pointed out that the city is growing and that traffic on both the main-line and suburban routes is increasing continually. Plans have been made for enlarging several of the stations and work has been commenced in some cases. Thus the Est Station is to have 28 tracks and 28 platforms; the Nord Station, 28 tracks; the Lyons Station, 21 and later 28 tracks. For the St. Lazare Station, where widening is impracticable, an underground station is proposed to serve the electrified lines. The Montparnasse Station has been relieved by the construction of the first part of a new station at the Avenue du Maine; this will have 14 platform tracks and will be for main-line trains, the present Montparnasse Station being then used exclusively for suburban traffic. Enlargement of the Paris-Orleans terminal at the Quai d'Orsay is also impracticable and in view of the traffic difficulties it is proposed to establish at the next station, at the Rue d'Austerlitz, a new 6-track terminal for the electric trains, this railroad having both suburban and main-line electrification.

Letters to the Editor

Social Graces for Engineers

Sir—Mr. Lavis' comments in your issue of May 23, 1929, p. 843, on Sidney J. Williams' article on "Education of Engineers," is appreciated. American engineers can well emulate the British engineer in his culture and refinement under even the most unfavorable conditions. As an American, I realize their superiority in respect to the "social graces and amenities" and their respect for the status of engineering work. We, as a whole, seem to feel and act as if we were in a trade instead of a profession. Their standards are high and they stick to them stubbornly and with dignity.

My opinion is based upon several years work as a junior civil engineer, with a large British company, in the tropics of a semi-civilized country. I admired, also, their clean sportsmanship and consideration of others amidst heat, pestilence and danger. They "carried on" in a fine manner.

We would do well to study their methods and results in these things, at least, and to appreciate these qualities as exemplified so well by our Army Engineers, and by their assistants, in general.

GEO. F. WHITTEMORE.

St. Louis, Mo.

A Call from the Past in Concrete

Sir—The communication by A. F. Gilman which appears in May 2 issue of *Engineering News-Record*, p. 721, reveals an old school concrete man—a call from the past, the old unlighted way.

The new way is stripped of such mysteries as shoving one's arm to the elbow into a buggy of plastic concrete and pull out a handful, thereby, forsooth, "applying a test more practical and yet more critical than any yet devised by any laboratory anywhere." Is it not miraculous that a labor foreman can, by dire predictions, frighten the new order into running through *a few batches* to suit his specifications (1:2:4+) and therewith produce *thousands of square feet* of concrete without a blemish!

Why not shake off groping in such darkness and uncertainty in concrete making and herald the clear and simple and sure way, namely, control of the cement and water ratio for definite strength (quality) concrete and let best workability and homogeniousness and economy regulate the proportioning of the sand and course aggregate. It eliminates speculation and uncertainty and mystery.

Prof. Duff Abrams and the Portland Cement Association have elevated concrete making to an art. Let us heartily hail and eagerly apply this most remarkable discovery in concrete making and forget the years we spent groping in darkness and mystery.

GEO. J. GRIESENAUER,
Cement Tester,
C. M. St. P. & P. Railroad Co.

Chicago, Ill.
May 9, 1929.

News of the Week

Agreement Reached on West Side Improvement Plan for New York City

Elimination of N. Y. Central R. R. Surface Trackage Assured at Cost of $175,000,000

ELIMINATION of all N. Y. Central Railroad grade crossings along the west side of New York City from Canal St. to Spuyten Duyvil has been assured by the approval of the committee as a whole of the New York City Board of Estimate of a comprehensive plan worked out by the engineers of the city and the railroad company for the improvement of the west side. Although actual contracts have not been signed, it is stated that most of the details have already been mutually approved. The estimated cost of the enlarged plan is $175,000,000, including some smaller public improvements to be made in connection with the railway elimination. It is stated that the railway company will pay $110,000,000, the city $50,000,000, and the state $15,000,000 of the cost of the improvement.

Details of the plan provide for an elevated structure through a private right-of-way to carry the railroad tracks from Canal St. to the 30th St. yards. From here they will continue through a subway to the 60th St. yards, and thence along the river to the upper end of Manhattan Island. Above 60th St. the tracks will be roofed over either by an express highway or by a roof which will be landscaped.

A special committee of architects appointed by the mayor to study the landscape features of the plan submitted both a majority and a minority report. The former favored the express highway on the roof over the tracks, while the latter recommended a landscaped roof and the placing of the express highway on the river bank. This disagreement was, however, regarded as incidental, and action on the two reports was deferred until a later date.

Florida Enacts Bills Providing for Flood Control and Drainage

Legislation providing for flood control and drainage in the Everglades region of Florida was passed May 29 by both houses of the state legislature. This took the form of two interlocking bills, the first providing for the creation of a flood control commission of ten members empowered to negotiate with the federal government for aid in building levees for Lake Okeechobee and enlarging the St. Lucie canal and the Caloosahatchee River, and also to issue bonds to the amount of $5,000,000 for this purpose. The second bill creates another ten-man commission for drainage work empowered to issue $3,000,000 in bonds for funding and retiring outstanding debts of the district. Each commission will be made up of the present five trustees of the internal improvement fund, supplemented by five additional members to be appointed by the governor to represent the district.

Chats Falls Project Approved by Canadian Government

Plans have been approved by the Canadian government for a new hydroelectric project on the Ottawa River, to be undertaken by the Chats Falls Power Company at an estimated cost of $2,500,000. The proposal involves utilization of the head of water available between the water level immediately above Chats Falls and the water level of Lake Deschenes by works situated entirely within the province of Quebec. The power station will be designed for an installation of two 15,000 hp. units operating under a head of 37 ft. The station will be capable of extension so as to utilize the total flow of the Ottawa River at this point at a maximum head of 55 ft.

Ames Resigns From Louisiana Highway Department

L. R. Ames, who was appointed state highway engineer for Louisiana early this year, has resigned because he has not been allowed to proceed with highway construction untrammelled by political manipulation. Mr. Ames, who had been connected with the engineering staff of the North Carolina Commission, went to Louisiana only after assurances that the state's highway work would be "free from any suspicion of political manipulation." Mr. Ames, in his statement, says that he accepted the position reluctantly because of his knowledge of the unfortunate history of highway organizations in states where operations are conducted with a view to political expediency. Finally, when Governor Long had increased the salary offer to $13,000 and had given renewed assurance that he would have ample authority and full responsibility, he accepted. The promised authority was withheld, however, Mr. Ames states, and the necessary reorganization of the highway work could not be brought about, with the result that the "chronic state of disorder" of the state highway department has continued. "No rational procedure has been developed," Mr. Ames stated. "Purchases were made and employees removed without my knowledge and consent. My duty to the state and to my own self-respect and reputation made my resignation mandatory."

Six Killed as Caisson Air Lock Tears Loose at Welded Connection

Impact of Bucket Believed to Have Caused Accident on Hackensack River Bridge Pier

SUDDEN FAILURE of a welded connection between the shaft and air lock on a pneumatic caisson being sunk for a pier of the Hackensack River bridge near Jersey City, N. J., caused the caisson to drop, smothering six workmen in the soft river mud. The accident occurred about 7:35 p.m., May 29, on the center lock of three on caisson No. 7, which is being used in the construction of one of the main lift-span piers for the new combined Pennsylvania Railroad-State of New Jersey highway bridge. The caisson is 56 ft. long by 18 ft. wide and will form the south half of the pier. A similar caisson to be sunk later will form the north half.

At the time of the accident sinking had progressed to approximately 53 ft. below water level, or 23 ft. below the river bed. All of the caissons on this job are being sunk to rock, which is approximately 105 ft., below water level. Three air locks were used on this caisson, being combined man and material locks 54 in. in diameter connected to the working chamber by a 4 ft. diameter steel shaft. The accident occurred in the center lock and was due to the failure of a welded joint in a reducing section between the lock and the shaft. This immediately released the air pressure and dropped the caisson about 5 ft. A detail of the lock showing the connection to the shaft is shown in the accompanying illustration.

Immediately after the accident the soil was found practically up to the deck of the working chamber at both ends of the caisson, and within 30 in. of the deck at the center shaft. There was no inrush of water as the caisson settled into the soft clay, temporarily sealing itself. There were fourteen men in the working chamber, six in the south end and eight in the center section. A bucket was being hoisted in the center shaft and also one in the south shaft. After the accident the south shaft was obstructed due to the bucket being jammed across the shaft opening when the caisson settled. The center and north shafts were clear.

Three men escaped up the open center shaft. Rescue parties went down this shaft and released five more, who were held by the soft soil. The rescue party could not get into the working chamber through the south shaft due to the jammed bucket, and access to the south section where the remaining six men

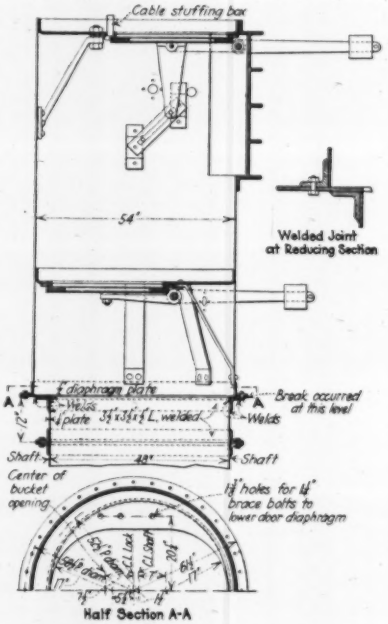
were buried was blocked by mud. However, rescue work was carried on from the center shaft until no further answers to signals were received from the entombed men, after which an air lock was placed on the center shaft and the air pressure re-established in the working chamber about midnight. The last of the six bodies was removed at 1:30 p.m. May 30.

Examination of the equipment showed that a welded joint in the reducing piece between the air lock and the shafting had parted, the lock falling into the cofferdam of the caisson. The top door of the lock was dislodged and lying loosely in the lock. The loaded bucket, which was being hoisted from the center shaft at the time of the accident, was later found in the cofferdam at the top of the caisson near the center shaft. The bail of the bucket, of very strong construction, was deformed. The joint in which the failure occurred had been welded to the diaphragm plate at both edges of the flange of the angle, as is shown in the illustration.

Customary practice up to within the last two years has been to use riveted and bolted joints on all this class of equipment. The rapid advance in welding and its supposedly greatly increased strength over riveted and bolted joints influenced the use of the welded joint on this work. A bolted joint in a 4 ft. diameter shaft would have 36 ¾ in. diameter bolts, which would give a safe load at the root of the threads of approximately 76 tons and a probable rupture load in excess of 150 tons. The welded joint was estimated to give a safe load in excess of 200 tons. Stress on this joint at 23 lb. per sq.in. air pressure (the pressure on the caisson when the failure occurred) would be approximately 22 tons. The reducing section in which this failure occurred was new and was delivered May 6. It was made by an experienced company which has manufactured this class of equipment for the contractor for the past six years.

Probable Cause of Failure

As yet investigations have failed reveal any absolutely definite cause of the failure of the welded joint. The most probable cause is that the hoisting engineer pulled the bucket against the head of the air lock with such an impact that the welded joint was torn loose. A careful review of the position of the bucket in the center shaft at the time of the accident is most important. All witnesses state that the bucket was being hoisted in the shaft. The hoisting engineer states that it was some 30 ft. above the deck of the caisson when the explosion took place, and that he did not see the marks on his cable which would indicate that the bucket was in the lock. The hoisting cable being used was a ¾-inch line and was practically new, with an estimating breaking strain of approximately 25 tons. The cable broke just above the cone forming the clip to which the bail of the bucket is fastened, and the break indicates the rupture occurred by a direct pull, as the breaks in the strands were distributed through a length of 4½ ft. This would not be the case had the cable been bent and broken by the falling lock, which would probably have caused a shear fracture rather than a direct tension break. Circumstantial evidence indicates that the bucket hit the upper door of the lock at a velocity which was sufficient to break the cable and also the welded joint in the reducing piece. This is not the first time that a bucket has hit the upper door of a lock with sufficient velocity to break the hoisting cable, but such impact has never before injured



DETAIL SHOWING AIR LOCK, SHAFT AND WELDED JOINT, THE FAILURE OF WHICH CAUSED THE DEATH OF SIX MEN

equipment consisting of an air lock, reducing section or shafting, as this equipment is designed to withstand a strain many times that of the breaking strain of the cable. It seems probable that, had the bucket been below the top of the lock when the accident occurred, the lock in leaving the vertical position would have held the cable fixed in the 6 in. cable stuffing box, so that the cable would have broken where it left the stuffing box, on the outside, and not inside the lock right at the bail.

The air lock that failed had been used within the past three weeks on one of the other caissons on this job on which 43 lb. of air pressure was used. The air shafting was new and manufactured for this work.

The Foundation Company, of New York City, is sinking the piers, having a contract directly with the Pennsylvania Railroad.

Freeman Scholarship to Be Awarded July 1

Announcement has been made by George T. Seabury, secretary of the American Society of Civil Engineers, that applications will be received up to June 15 for the Freeman Traveling Scholarship for the year 1929-1930. A candidate, to be eligible, must be an American citizen between the ages of 24 and 35, a graduate of a technical school of recognized standing and now engaged in teaching in a school in which hydraulics forms an important part of the curriculum. The candidate must be familiar with the mathematical treatment of hydraulic problems and well grounded in general mathematics. Working knowledge of the German language is considered essential. It is desirable that the candidate be a member in one of the grades of the American Society of Civil Engineers, and that he shall have experience in hydraulic design and construction.

The scholarship amounts to $1,800, of which $600 will be paid to the successful candidate on July 1, 1929, and $100 a month for the twelve months thereafter. It was established by John R. Freeman, well known hydraulic engineer, to promote in this country a greater interest in work of European hydraulic laboratories, and to make American engineers more familiar with European practice in hydraulic design and construction.

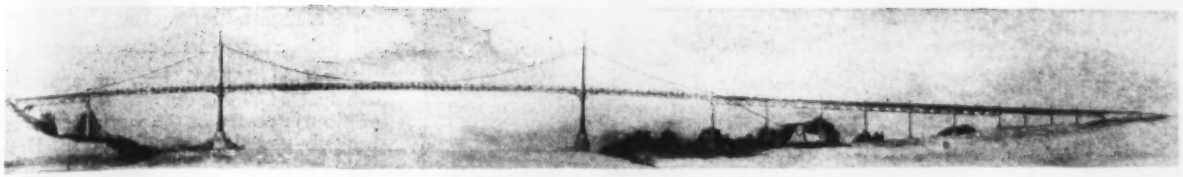
Clearance of 200 Ft. Required for Hudson River Bridge

Announcement was made May 29 that the application of the North River Bridge Company for permission to bridge the Hudson River at 57th St., New York City, would not be granted unless plans for the structure should be revised to provide a 200-ft. clearance above mean high water at the center, and 185 ft. at the pierhead lines. Plans as submitted for approval by the bridge company provided only 175 ft. of clearance at the center of the span.

The announcement was made by James W. Good, Secretary of War, and the decision was concurred in by Major-Gen. Edgar Jadwin, Chief of Engineers. No appeal is possible from this ruling.

Examiner Denies Necessity for Railroad in California

In a report presented to the Interstate Commerce Commission Examiner Haskell C. Davis suggests that the present and future public convenience and necessity does not require the construction of approximately 138 miles of new line in California by the Western Pacific California Railroad Company, a subsidiary of the Western Pacific Railroad Company. The proposed line would extend from Nile Garden up the San Joaquin valley to a point on Kings River 21 miles southeast of Fresno, Calif. The examiner states that all towns on the proposed line are already served by transportation facilities. It was contended by the Santa Fe and the Southern Pacific that the proposed line would closely parallel and duplicate existing railways which now furnish adequate and competing service.



PROPOSED ST. JOHNS BRIDGE OVER WILLAMETTE RIVER AT PORTLAND, OREGON

Preliminary plans for this new $4,000,000 bridge across the Willamette River at Portland, Ore., will soon be submitted to the U. S. War Department by the county commissioners. The bridge is to be of the suspension type with a clear span of 1,207 ft. and a vertical clearance of 205 ft. above mean low water. Each of the suspended side spans will be 431 ft. long, and the total length of the bridge and approaches will be 3,850 ft. There will be a 40-ft. roadway and two 5-ft. sidewalks. Steel towers 350 ft. high will be set on concrete piers extending 60 ft. above water level. The design and construction of the bridge will be under the direction of Robinson & Steinman, of New York City. The sanction of shipping interests at Portland has already been obtained for the plans.

South Texas Damaged by Floods

Heavy rainfall extending over a period of several days culminated May 31 in floods in the southern section of Texas, affecting the Brazos, Neches, Sabine, Trinity, Colorado and Guadalupe rivers and the cities of Houston, Beaumont, San Antonio, Victoria and Laredo, as well as a number of smaller towns. Thousands of acres of farm land were inundated and property damage amounting to millions of dollars is reported. Preliminary reports state that seven lives were lost, with many districts not yet heard from.

One result of the flood in Houston was a scarcity of drinking water and an unusual fire hazard, caused by the flooding of the central pumping plant. Although six water substations were still functioning, the pressure dropped very low in the mains and business houses with private wells were called upon to supply water to supplement the city system. Serious results would have ensued had a fire started at this time.

Boundary Commission Proposes to Stabilize Rio Grande

The Secretary of State has received a report made by the International Boundary Commission on the engineering feasibility of a plan to prevent further changes in land areas and remove a flood menace of the Rio Grande near El Paso, Texas, and Ciudad Juarez, Mexico. The Joint Commission has for several months been actively engaged in field surveys and the assembling of engineering data upon which to develop a plan for the rectification of the Rio Grande where it is the boundary line between the United States and Mexico between El Paso, Tex., and the canyon below Fort Quitman.

Existing treaties between the United States and Mexico carry provisions for the settlement of national sovereignty over areas affected by the natural meanderings of the river, but these treaties do not take into consideration any provision for artificial changes now so strongly urged and in demand because of the intensive cultivation and improvements that have been made on areas adjoining the river. The report now submitted to the two governments for consideration and further development contemplates artificial rectification of the river, generally following and straightening the present channel, providing additional storage, and a system of levees to confine flood flows. This work represents the initial step in having available for the first time a definite plan upon which future negotiations between the two countries may be based.

Both governments have long sought some means of solving the national and local problems arising from the shifting and meandering channel of the Rio Grande, the menace of floods to the cities of El Paso and Juarez, and the difficulties of law enforcement. The river which generally forms the boundary line between the two countries has in its meanderings created detached areas from one country to the other as a result of the natural changes peculiar to sedimentary streams, causing uncertainty of land titles and property ownership.

The alignment of the channel proposed has been so chosen as to equalize the areas which will be cut from one nation with those that will be cut from the other, and this treatment brings about the result that neither country will gain or lose territory.

Special Railway Accommodations for A.W.W.A. Convention

For the convenience of those attending the American Water-Works Association convention in Toronto, Ont., June 24-28, a number of railways have made special arrangements. A train will leave the Pennsylvania Station in New York City at 6:25 p. m. June 23 to accommodate delegates from New York, Philadelphia and eastern Pennsylvania. A similar train will leave Pittsburgh by the Pittsburgh & Lake Erie Railroad the evening of June 23. From Chicago two trains will be run, the first leaving at 9 p. m., running over the Michigan Central by way of Niagara Falls, with a four and one-half hour stop-over at this point. The second, for those whose time is limited, leaves at 5:40 p. m. Monday, June 24. Those attending from New England will be served by a train leaving Boston at 3:40 p. m. on the 23d, stopping at Worcester, Springfield, Pittsfield and Albany.

It is particularly requested that tickets be purchased and Pullman reservations made early so that ample accommodations can be provided for all attending the convention.

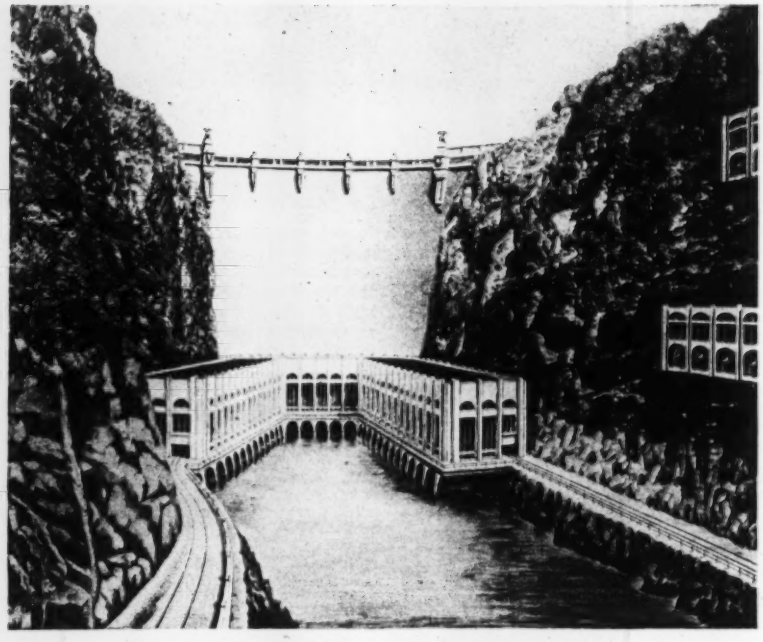
Lighting Institute Opened

Official opening of the Westinghouse Lighting Institute, a modern life-size demonstration of lighting principles, took place May 30 in New York City. It has been established by the Westinghouse Lamp Company for the benefit of the industry and contains, in the form of a model village, a completely lighted street lined by artificially lighted stores, a bank, theater, garage and service station, schoolroom, factory, offices, and a sample American home. All of these are fully wired and fitted with modern fixtures illustrating modern lighting practice. The village, which occupies the entire tenth floor of the Grand Central Palace, is intended not only for demonstration, but also for experimental purposes, and experimental facilities are offered to architects, engineers and other interested in lighting problems. Other features of the institute include a room in which models of public buildings may be placed and studied from the lighting standpoint, and also a full size model of Broadway as it appears from the Times Building, in which every illuminated sign has been faithfully reproduced in miniature and timed to flash as does the original.

The institute is now open to visitors from 10 a.m. to 5 p.m. daily, except Sunday. Special arrangements may be made for evening meetings and parties. Although the Westinghouse institute is probably the most elaborate now in existence, it is not the first, as a prototype has been in service for some time in the Edison Lamp Works of the General Electric Company at Harrison, N. J.

England to Build Super-Highway

Construction of a new 25-mile road between Liverpool and Manchester, England, has been assured by the acceptance of a bid of approximately $9,732,000 for the preliminary work submitted by Sir Lindsay Parkinson of Blackpool. The right-of-way will be 120 ft. wide, allowing for a roadway of 40 ft., two 10-ft. sodded parkways, two 20-ft. roads for slow traffic, and two 10-ft. sidewalks. Only the central 40-ft. roadway will be built at present. It is said that clearing the right-of-way will involve the demolition of 130 houses and the construction of 23 bridges. Of the cost, 75 per cent will be contributed by the national government.



BOULDER DAM AND POWER PLANT
According to a recent sketch by the U. S. Bureau of Reclamation.

Let Contracts for Bonnet Carre Spillway Project

The U. S. War Department on May 25 authorized the acceptance of bids for the construction of the Bonnet Carre spillway in Louisiana, a unit of the new Mississippi flood control project. Separate contracts were let for four sections, of which the first two went to the Boone & Webster Company, Cedar Keys, Fla.; section 3 to the McWilliams Dredging Company, New Orleans, La.; and section 4 to the Jahncke Service of New Orleans. The bids of the latter two companies were at first rejected as being too high, district engineers intending to do the work with government plant. The two firms protested, however, that sufficient information had not been given upon which to base estimates, and, as they were the low bidders in their respective sections, they were allowed to revise their figures.

Section 1 is classed as dry land work and involves the construction of guide levees totaling 560,000 cu.yd. The contract price was $173,600, to which the army engineers added $6,944 for supervision and inspection. The original estimate of the army engineers was $168,000, and the cost of doing the work with government plant was estimated at $224,560.

Section 2 is the same class of work, involving 400,000 cu.yd. The Boone & Webster bid was $116,000, to which was added $4,640 for supervision and inspection. The estimate of the Mississippi River Commission was $160,400.

Land in sections 3 and 4 is swampy, so that the hydraulic fill method of constructing the levees will be used. These sections are at the Lake Pontchartrain end of the spillway. Section 3, awarded to the McWilliams Dredging Company for $670,030, calls for 2,300,000 cu.yd. of hydraulic base, 360,000 cu.yd. of cutoff ditches, and 250,000 cu.yd. of superimposed fill. The supervision charge is $32,728, and the estimate of the Mississippi River Commission $577,750.

Section 4 was awarded to the Jahncke Service for $865,300. This includes 300,000 cu.yd. of hydraulic base, 310,000 cu.yd. of superimposed fill, and 470,000 cu.yd. of cutoff ditch. The estimate submitted by the army engineers was $746,050 while the amount to be charged for inspection is $37,600.

Sloan Resigns as N. J. Road Head

William G. Sloan, chief engineer of the New Jersey State Highway Department, tendered his resignation from that post June 4, to take effect July 15. He will become manager of the London office of the Foundation Company of New York City at a salary said to be more than double that which he is receiving from the state.

Mid-Hudson Bridge Pier Finished

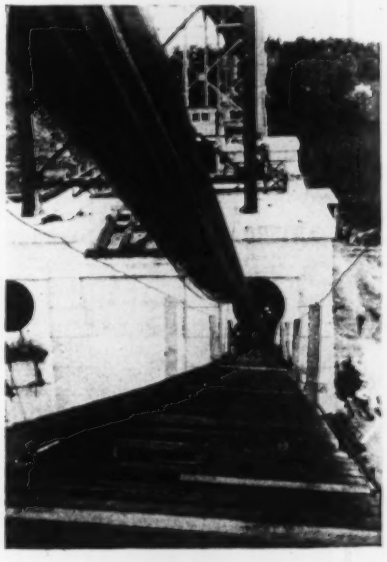
Foundations for the Mid-Hudson bridge at Poughkeepsie, N. Y., were completed May 22 when the last stone was put into place on the east pier. This is the pier which, on July 27, 1927, listed to an angle of 40 deg. while being sunk, and which was not completely righted until October 8, 1928. The caisson was 60x136 ft. in plan and weighed, at the time it listed, 3,600 tons. The contractor on the foundations was Blakeslee-Rollins Corporation. Modjeski & Moran were the engineers.

Largest Generator Unit Placed in Service

Rated at 165,000 kw., or approximately 222,000 hp., the largest generator of electric power in the world has been formally placed in operation at the Hell Gate station of the United Electric Light & Power Company, New York City. The unit, which is operated by steam, is of the cross-compound turbine type, consisting of two turbines operated by high and low pressure steam. Each of these drives an electric generator rated at 80,000 kw., and, in addition, the low-pressure turbine drives a third generator, rated at 5,000 kw., supplying power for use in the station. The two main generators are inclosed in a single semi-circular housing into which cooled air is blown for ventilating purposes. Steam is supplied at 265 lb. gage pressure. To condense it, 155,000 g.p.m. of cooling water are required—an amount about equal to the daily consumption of the Borough of Brooklyn.

It is interesting to note that the output of this single unit would light 1,000,000 homes simultaneously, or provide excellent illumination for a highway running twice around the world. It produces more power than could the entire population of Chicago working in unison. Nearby, in the same station, is the second largest unit, rated at 214,000 hp. The world's largest water-power generator develops about 80,000 hp.

ONE OF THE MOUNT HOPE CABLES BEFORE REMOVAL



Backstay section of east cable at north, or Bristol, end of the Mount Hope suspension bridge, being dismantled. One of the lower strands of the cable had more than three-fourths of its wires broken at the north strandshoe. Upon removal of the temporary tie-wires this strand was found to have loosened extensively in the backstay section, although the broken wires had previously been spliced.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

Seek Pact Allocating Colorado River Water—Muscle Shoals Question Revived by Senate

NEGOTIATIONS toward a tri-state pact under the Colorado River agreement have been carried on in Washington during the past few days by representatives of California, Arizona, and Nevada. Delegates from Colorado, New Mexico, and Wyoming also are in attendance, although not directly concerned in the proceedings, which involve the division of the lower basin waters as allocated in the agreement. Although conditions may change before the conference is over, the present outlook seems to be that Arizona will seek a Supreme Court decision to determine her rights. Even so, it is not thought that such action would delay construction. The Boulder Dam act does not become effective until June 21, and about a year's time probably will be taken in arranging contracts and other details preliminary to a work of such magnitude. By this time, the Supreme Court could act and all legal difficulties presumably could be settled.

Present discussion hinges about the Gila River, which Arizona claims is not a part of the Colorado River system for purposes of the act because it joins the main stream close to the Mexican border below all contemplated diversion. Looking ahead 50 or 100 years, when the seven states are using their quota of allocated waters, if there is no surplus left for Mexico, some of the Mexican demand will have to be taken from the state apportionments. Arizona's contention is that to include the Gila in the system would deprive her of rights on the main stream if and when this shortage begins to be felt. In other words, Arizona claims exclusive right to the Gila and holds that such right shall not limit the share of water to be received from the Colorado River as divided in the agreement.

As Monday's meeting came to a close, it was suggested by Francis Wilson of New Mexico, acting as chairman, that such problems might well be deferred until they materialized, which might be never. He proposed what another delegate dubbed a "companionate agreement" whereby the lower basin states might use their allocated water without difficulties until a shortage occurred, at which remote time they could settle their differences on a basis of fact rather than forecasting

Shall It Be the Hoover Dam?

Under the terms of a resolution introduced by Representative Taylor of Colorado, the name of the structure provided for in the Boulder dam act will be changed to the Hoover dam. Mr. Taylor believes that this is fitting recognition of the service Mr. Hoover rendered as the official representative of the federal government in the negotiation of the Colorado River compact. This compact was signed in Santa Fe, New Mexico, on November 24, 1922.

Mr. Taylor believes also that it is appropriate that what will be the highest dam ever built shall bear the name of an engineer whose ability and reputation is so universally established as Mr. Hoover's. Not only is it believed proper to change the name of the dam for these reasons, but it is pointed out in addition, that the name Boulder dam applied to the structure is an incorrect designation since the location in the adopted bill was changed to Black Canyon.

Rio Grande Diversion

The diversion of 1,250 sec.ft. from the Rio Grande River, 40 miles above Eagle Pass and its return to the stream 30 miles lower down, in no way affects the interests of navigation and the proposed project of Maverick County Improvement District No. 1 and does not come within the jurisdiction of the Federal Power Commission. This is understood to be the opinion of the district engineer who recently reported on the project. The Irrigation District plans to use the water to develop 7,000 hp. Formal objection to the development has been lodged with the Power Commission by the American members of the International Water Commission. This Commission is engaged in a study of the Rio Grande and Colorado Rivers in an effort to work out an agreement between Mexico and the United States for the allocation of waters. Any additional diversions on the American side at this time would complicate an already intricate situation, it is contended.

Muscle Shoals Bill Re-introduced

The Norris resolution for the creation of a government corporation for the control of the Muscle Shoals properties was approved on May 29 by the Senate Committee on Agriculture and Forestry. This is almost identical with the measure which was passed by both houses of Congress last session and killed by the pocket veto of President Coolidge. The recent Supreme Court decision on a similar case upholds the veto and makes it necessary for the resolution to be reintroduced.

One new section has been added by Senator Norris to provide payments to Alabama and Tennessee in lieu of taxation returns which these states would have received had the properties been developed by private interests.

Commenting on the resolution, Senator Norris pointed out that Congress has deliberated for eleven years without bringing the Muscle Shoals property, which cost the government upwards of $120,000,000, into economic use. He stated that the resolution provides a far-reaching program for the development of power, flood control, navigation, and fertilizer research. The proposed Cove Creek dam, he said, will create the largest reservoir in the East, which will double the power output at Dam No. 2 and will be an important factor in flood control on the Tennessee and Mississippi Rivers. If this reservoir were privately operated, he declared, the attempt would be to keep it as full as possible for power storage purposes thus leaving little excess capacity for flood control.

In the committee discussions, it was pointed out that with power becoming less important in nitrogen fixation a power surplus is left at Muscle Shoals which must be used for purposes other than fertilizer production.

Passage of the resolution would set up a corporation having three directors appointed by the President of the United States. The directors would in turn appoint a manager and two assistant managers.

Other proposals for development by the Cyanamid Company or by the Farmers Federated Fertilizer Corporation probably will be introduced on the floor of the Senate by Senators Black and McKellar.

Engineering Societies

CALENDAR

Annual Meetings

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; annual meeting, Atlantic City, N. J., June 24-28.

AMERICAN WATER WORKS ASSOCIATION, New York; annual meeting, Toronto, Canada, June 24-28.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; annual convention, Milwaukee, Wis., July 10-12.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; annual meeting, Mexico City, Aug. 26-28.

The Colorado Engineering Council, representing over 1,500 professional engineers in that state, has adopted a report approving the recent lease of the pioneer bore of the Moffat tunnel by Denver to provide for its future water requirements.

The Baltimore Section, American Society of Civil Engineers, at a meeting May 21 elected the following officers for the year: President, S. L. Thomsen; vice-president, W. R. Edwards; secretary-treasurer, J. W. Armstrong.

The American Association for Promoting Hygiene and Public Baths, at its annual convention in Buffalo, N. Y., May 17-18, decided to open the membership list, hitherto restricted to individuals, to corporate and other municipal bodies, institutions and welfare organizations, commercial bathing places, and manufacturers of materials and equipment used in bathing places. Formation of state sections of the society was also authorized.

The Society for the Promotion of Engineering Education will hold its annual meeting at Ohio State University, Columbus, Ohio, June 19-21. The theme of the convention will be "The Graduate and His Work," and will be treated in its various phases by R. I. Rees, of the American Telephone & Telegraph Company; C. R. Dooley, of the Standard Oil Company of New York; H. S. Evans, of the University

of Colorado; P. M. Lincoln, of Cornell University; Louis Mitchell, of Syracuse University, and William T. Magruder, of Ohio State University. At an evening meeting Charles F. Kettering, president and general manager of the General Motors Research Corp., will discuss "Engineering Research." Addresses will also be made by L. W. Wallace, of the American Engineering Council, and Arthur E. Morgan, president of Antioch College.

CITY PLANNING CONFERENCE—At the City Planning Conference held recently at Buffalo, N. Y., the following officers were re-elected: President, Edward M. Bassett, New York City; vice-president, Harland Bartholomew, St. Louis, Mo.; secretary, Flavell Shurtleff, 130 East 22nd St., New York City.

THE BALTIMORE ENGINEERS CLUB on May 29 presented a silver pitcher and tray to H. Carl Wolf, its president, who has resigned as chief engineer of the Maryland Public Service Commission to accept a position in Chicago.

Personal Notes

Maj. Gen. MASON M. PATRICK, U.S.A., retired, has been appointed a member of the Public Utilities Commission of the District of Columbia. He succeeds John W. Childress, resigned. Although General Patrick's appointment is for one month only, it is expected that he will be reappointed at the expiration of this time.

LYMAN E. BISHOP, consulting hydraulic engineer of Denver, Colo., has accepted a two-year commission as consulting engineer for irrigation construction in Soviet Turkestan. He sails from New York June 12 and, after a brief stay in Moscow, will go directly to Tashkent, Soviet Turkestan, U.S.S.R. Mr. Bishop's office in Denver will be discontinued until his return to this country.

J. G. CARROLL, LOUIS E. CARROLL and GEORGE W. SHARP have organized Carroll-Sharp Construction, Ltd., to carry on a general contracting business with offices in Toronto and Ridgeway, Ont. The new firm will specialize in waterworks, sewers and sewage disposal plants.

J. W. FOLLIN has been elected secretary of the Philadelphia Building Chapter, Associated Pennsylvania Constructors, succeeding William D. Hill, who has resigned to accept an executive position with Henry E. Baton, Inc., building constructors. Recently Mr. Follin has been with the United Gas Improvement Company, but prior to this was consulting engineer for the Associated Pennsylvania Constructors, which is the state branch of the Associated General Contractors of America. He is a graduate of the University of Michigan and has held positions with the Philadelphia Bureau of Municipal Research and the Pennsylvania Department of Highways. Mr. Follin is also director and nominee for vice-president of the Philadelphia Section, American Society of Civil Engineers.

E. L. COILE has been appointed assistant state maintenance engineer of the Tennessee State Highway Department. The post is a newly created one made necessary by the application of 1c. of the state gasoline tax to the upkeep of county roads.

R. S. ARTHUR, formerly in charge of the Chicago office of the Dravo Equipment Company, has been appointed manager of the midwestern branch office recently opened by the Aeroil Burner Company, of West New York, New Jersey.

C. M. THOMAS has been appointed city engineer of Burlingame, Calif., succeeding JAMES M. JAMES, retired.

T. E. LUNDY, of Pueblo, Colo., is now engaged on municipal improvements in Jacksonville, Tex.

OSCAR DUNN, head of J. M. Dunn & Son, contractors, of Knoxville, Tenn., has been made president of the Chamber of Commerce of that city.

Obituary

PETER GILLESPIE, professor of civil engineering in the University of Toronto, one of the most inspiring of Canadian engineering educators, died suddenly May 26 at the age of 56. In various teaching capacities he had served the university for 25 years. In earlier years he had spent many summers in railway location and construction with the Canadian Northern Railway and in power plant construction and municipal work. Much of his time recently, apart from teaching, had been devoted to engineering research and his investigations of haunched beams, reservoir walls, reinforced concrete poles, reinforced concrete chimneys and structural welding contributed much to the knowledge of these subjects. His advice was frequently sought in a consulting capacity. Always an active supporter of engineering organizations, he was a member of the Engineering Institute of Canada, and had served as branch chairman, councillor and vice-president. In the Canadian Engineering Standards Association he was an active figure, having served a term as vice-chairman and as member and chairman of many important committees.

Gen. GEORGE S. FIELD, one of the noteworthy figures in the field of bridge construction 40 years ago, died in Buffalo on May 18 at the age of 83. General Field, who was born at Springfield, N. Y., began engineering work on the Erie Railroad, but after some years entered bridge construction and was an associate of George S. Morison in the firm of Morison, Field & Company. Later, with Edmund Hayes, he owned and operated the Central Bridge Works in Buffalo. In 1884 the members of this firm joined with Charles MacDonald, Thomas C. Clarke and the firm of Kellogg & Maurice in forming the Union Bridge Company, a firm which, until its sale to the American Bridge Company in 1900, maintained a leading position in American bridge construction. During that time it built a number of noteworthy structures, including the cantilever bridge over the Hudson at Poughkeepsie. Perhaps its most noteworthy undertaking was the building of the Hawkesbury bridge in Australia, which it obtained after a world-wide competition among bridge building companies, the Edge Moor Iron Company taking second place. The Hawkesbury bridge was notable not only for the length and dimensions of spans of the superstructure, but also for its deep foundations, which were open caissons sunk to a maximum depth of more than 170 ft. Mr. Field retired from the company before he was 50, and spent the remainder of his life in other industrial and business pursuits.

RALPH W. NICKERSON, well-known structural engineer, died recently, at the age of 47. Graduating from Worcester Polytechnic Institute in 1903, Mr. Nickerson was employed by the American Bridge Company, with whom he continued until 1925. From 1911 until 1925 Mr. Nickerson was in the designing department of the New York office, during which time he was responsible for the design of structural steel and many large foreign and domestic undertakings. On July 1, 1925, he started in business as a consulting engineer, and late in 1928 became connected with the structural steel department of the George A. Fuller Co. He was a member of the American Society of Civil Engineers.

BENJAMIN F. DARLING, formerly city engineer of White Plains, N. Y., died at Gainesville, Ga., May 27, at the age of 65. He was born at Smithtown, L. I., and served some time in the United States Navy before becoming a civil engineer. From 1895 to 1905 he was with the firm of Bryne & Darling, of White Plains. Mr. Darling's last engagement was with the City of Toledo, Ohio, from which he retired after a nervous breakdown.

FREDERICK AUSBERT DELAVAU died in Rochester, N. Y., May 28, at the age of 55. He was born in Rochester and began his engineering career with Gray & Storey, civil engineers, in 1889. In 1898 he was appointed draftsman for the city engineering department, with which he remained until 1928, working his way up through the grades of assistant engineer, office engineer, and deputy city engineer, to his final rank of supervising city engineer. Mr. Delavau was a member of the American Society of Civil Engineers, and was treasurer of the Rochester Engineering Society.

Construction Equipment and Materials

Standards Bureau Establishes Cement Testing Laboratory

Supported jointly by the federal government and the American Society for Testing Materials, a new reference laboratory for portland cement has been established at the U. S. Bureau of Standards, Washington, D. C. The object of the laboratory will be the testing of cement, the calibration of machines and instruments used in cement testing and the training of men for commercial cement testing laboratories. The work will be under the immediate supervision of P. H. Bates, chief of the clay and silicate products division of the Bureau of Standards. The staff will consist of five experts who will work partly at the laboratory in Washington and partly in the field. Service will be available upon application only and will be rendered as nearly as possible in the order in which applications are received. It is the intention of the laboratory to issue certificates covering machines tested by it. A special committee of the main committee on cement of the American Society for Testing Materials has been appointed to co-operate in conducting the work of the laboratory.

Osgood Buys Oil Engine Plant

All outstanding capital stock of the Power Manufacturing Company, Marion, Ohio, has been purchased by the Osgood Company of that city. The Power Manufacturing Company produces the "Primm" oil engines and has recently developed a vertical engine to be built in sizes ranging up to 360 hp. which is expected to be a valuable addition to the present line of horizontal engines. It also operates a gray iron foundry, which, under the new plan, will furnish the Osgood Company and allied industries with castings for the Osgood products.

Road Builders Assn. Asks Aid of Manufacturers

Manufacturers of road building machinery have been asked by Charles M. Upham, secretary-director of the American Road Builders Association, to give their aid and active support to three separate activities of the association. The first of these involves a series of educational bulletins to the distributed by the association, the first of which is now in preparation. It will deal entirely with road grading and include such subjects as cleaning, grubbing, ditching, excavation, borrow, overhaul, and subgrading. Material is now being collected for this bulletin, which will be written in a descriptive manner, and it is requested that manufacturers send photographs and descriptions of any equipment used in the grading of highways to the offices of the association in Washington, D. C.

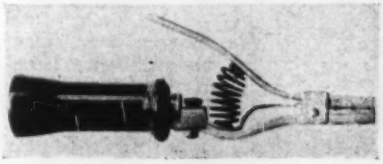
In connection with the Pan-American Congress to be held in Rio de Janeiro, Brazil, in August, 1929, the association is urging President Hoover to appoint as one of the official delegates to represent the United States the president of the American Road Builders Association. In support of this request it is necessary to show the standing of the association in the highway industry. Therefore, each member company of the manufacturers division has been requested to fill out a questionnaire showing the total valuation of the firm, the annual amount of business done in 1927 and 1928, as well as an estimate for 1929, subdivided into domestic and export trade. From these figures it is hoped to get the total valuation of all firms represented by the manufacturers division and the approximate amount of business done each year.

Funds are also being solicited for the strengthening of the activities of the Pan-American division in an effort to spread knowledge of standard methods, specifications, equipment and practices through Central and South America. The American Road Builders Association and its manufacturers division have each contributed $5,000 to this work, provided an additional $10,000 is secured from the manufacturers directly interested. If this money can be raised, the Pan-American division will be enabled to extend its work tending to enlarge highway progress in Central and South America.

New Developments

New Electrode Holder for Metallic Arc Welding

A new type of electrode holder for metallic arc welding, designed for greater operator convenience, has been developed by the Lincoln Electric Company, Cleveland, Ohio. As shown in the accompanying illustration, the holder consists of a clamp which holds the electrode firmly with an easy release feature which permits changing electrodes quickly. It is claimed that the holder is exceptionally cool because the welding current is carried from the point of cable entry to the copper jaws by copper strips of low resistance. The copper tips on the jaws reduce the sticking of the electrode to the jaws, resulting in faster and easier change of electrodes and longer life for the holder. All metallic parts of the holder are coated with non-tarnishing cadmium plating.



Unusual Bucket Manufactured in Germany

A radical departure from usual design of buckets is represented by the Polyp bucket manufactured by Reichmann-Becker Polyp Company, Duisburg, Germany. As is indicated in the accompanying illustrations, the Polyp bucket may be termed a multiple flexible-blade bucket, the blades being not rigidly connected with one another.

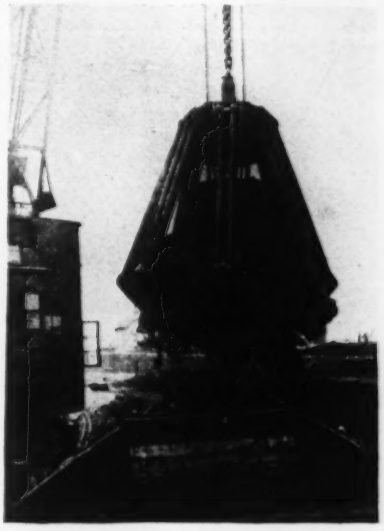


FIG. 1—OPEN TYPE BUCKET

FIG. 2—CLOSED TYPE BUCKET

out operating independently. It is claimed that they adjust themselves in every way to the material to be handled, digging their way in somewhat like the fingers of a hand.

The bucket is built in two types. The open type with 8 blades is used for handling steel scrap and other similar material while the closed type is designed for handling ore, coal, coke, gravel, sand and for excavating, dredging, etc. One of the principal advantages claimed for the bucket is that it is 100 per cent loaded with each lift. These buckets are built from the smallest size up to a capacity of 20 cu.yd.

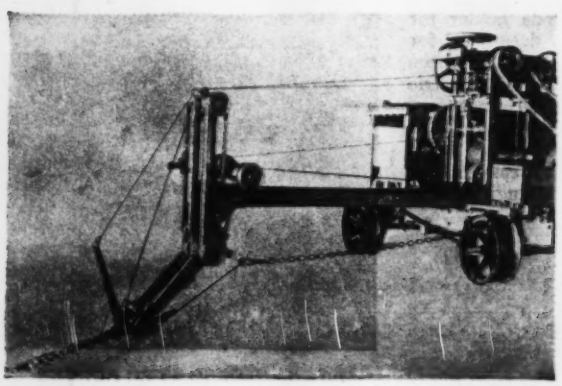
Self-Propelled Air Compressor for Railroad Service

A self-propelled air compressor unit has been developed by the Chicago Pneumatic Tool Company, New York City, which contains several unusual features. In addition to its self-

propelling feature, the machine incorporates air jacks which lift the unit from the rails and transverse wheels which roll it off the track to any desired location. A lifting bail is also provided in case a locomotive crane is handy. The compressor is gasoline engine driven and is available in a range of sizes as follows: 110, 160, 220, 265 and 310 cu.ft. per minute.

Railway Mowing Machine with Vertical Adjustment

A new improvement in the mowing machines manufactured by the Fairmont Railway Motors, Inc., Fairmont, Minn., provides for efficient use of the machine on very high rock ballast sections by the use of a vertical adjustment of the mowing blade. This adjustment arrangement is shown in the accompanying illustration, although the machine is here set for rather shallow cutting. Adjustment is made from the platform by means of the lower hand wheel. In addition to this vertical adjustment there is an in-and-out adjustment of the H beams and an adjustment of the shoe hinged to the bottom of the head.



Business Notes

FUSION WELDING CORPORATION, Chicago, Ill., has appointed F. O. Weber, sales manager for the Pittsburgh district. The company has also completed plans for the construction of new general offices adding over 8,000 sq.ft. to the space it now occupies.

WATERTOWN STONE PRODUCTS COMPANY, Watertown, N. Y., on May 29 entertained about 50 guests from the New York State Highway Department, the county highway department, the New York Central Railroad and from Syracuse and other nearby cities.

STODDARD-DICK COMPANY, Detroit, Mich., announces that George H. Stroben, for a number of years associated with Avery-Brundage Company, Chicago, and Homer H. Dowell, formerly with J. W. Dopp Company, Detroit, have become associated with their company.

GENERAL ENGINEERING WORKS, Chicago, recently incorporated and continuing the business of a former partnership under the same name, reports that it is now manufacturing its screw machine products at a plant at 4701 West Division St.

LINCOLN ELECTRIC COMPANY, Cleveland Ohio, has advanced B. W. Brown to the post of district sales representative with headquarters at Milwaukee, Wis. G. O. Forseth, formerly a sales representative at Detroit, has been promoted to district sales representative at Minneapolis, Minn.

FRANK T. FAY, sales manager of the asphalt department of the Standard Oil Company of New York, Boston Division, died suddenly at Boston, May 5. Mr. Fay was 70 years old. Graduated from the Worcester Polytechnic Institute in 1878, he had been with Socony ever since, making a notable record for 50 years in the service of the company. He was a pioneer in the road oil and asphalt business in New England, and had been in charge of the department which he headed throughout its existence.

New Publications

Pipe — NATIONAL TUBE COMPANY, Frick Building, Pittsburgh, Pa., has issued bulletin 11 devoted to copper-bearing steel pipe. Most of the ten pages are devoted to accounts of corrosion tests carried out by the American Society for Testing Materials, the Bessemer & Lake Erie Railroad and the U. S. Bureau of Standards on the subject of the corrosibility of copper-bearing steel.

Concrete Paving — SHEET CONCRETE PAVEMENT CORPORATION OF AMERICA, 51 E. 42nd St., New York City, has issued an illustrated bulletin, bringing out the advantages of concrete paving by the sheet concrete method, which separates top and bottom courses by means of a porous fabric to facilitate resurfacing. The bulletin gives standard specifications for paving by this method and a list of present installations.

Welding—LINCOLN ELECTRIC COMPANY, Cleveland, Ohio, is issuing a monthly sheet "Studies in Structural Welding," showing the latest applications of welding to structural work. This supplements a bulletin on the application of welding to the manufacture of machinery and equipment which has been appearing twice each month for some time.

Explosives—HERCULES POWDER COMPANY, INC., Wilmington, Del., is publishing a 14-p. illustrated booklet describing Hercoal-F, a new type of permissible explosive developed primarily for use in coal mining.

Pavements—KENTUCKY ROCK ASPHALT COMPANY, INC., Louisville, Ky., in a booklet "Kyrock in Chicago and Cook County" describes by photograph and text a large number of streets paved with their product in the vicinity of Chicago.

Car-Retarder Freight Yards—General Railway Signal Company, Rochester, N. Y., in its new bulletin 155 describes the design of yards equipped with all-electric car-retarders in connection with gravity switching. While the apparatus is described and illustrated, a large part of the bulletin is devoted to the track layouts and hump profiles of a number of individual yards having this equipment, together with particulars of their operation. Auxiliary to the retarders or track brakes are the motor-operated sliding skates, to check cars which move too fast beyond the retarders.

Buying Nickel Alloy Steels—INTERNATIONAL NICKEL COMPANY, INC., has published a bulletin entitled "Buyer's Guide for Nickel Steel Products." The bulletin's contents consist of a listing of manufacturers grouped as to products which utilize nickel alloy steels. Examples of the groupings are auto axles, roller bearings, bolts and nuts, castings, crankshafts, dies, eye-bars, forgings, gears and pinions, locomotive cranes, structural shapes, rivets, hand shovels, turnbuckles, valves and welding wire.

The Business Side of Construction

Construction Lead Is 31½ Per Cent Over Last Year

May Volume Highest on Record—Public Lettings Behind Last Year

May added $471,609,000 to the year's contract total, making it 31½ per cent larger than for the first five months of 1928. The weekly rate in May was $94,000,000 compared with $71,000,000 in May, 1928, an increase of 32 per cent.

The five months' total of nearly two billion dollars consists 73 per cent of private work, whereas a year ago this figure was 63 per cent. It is to be noted that total public construction this year amounts to just about the same as last year, the figures being $519,000,000 for 1929 and $533,000,000 for 1928. This 2.5 per cent decline in public lettings, though due chiefly to this season's lag in road work, is by no means confined to roads. Water-works, sewers, and public bridges are all a little behind last year's values at this time. Road lettings in May amounted to $78,000,000 compared with $45,000,000 in April and $83,000,000 in May, 1928. Lettings to date total $183,000,000, compared with $265,000,000 a year ago, a lag of 31 per cent.

This year's increase in engineering construction, therefore, is in private work. This is the case not only for commercial and institutional buildings, but for the broad unclassified group as well. In millions of dollars, the figures for this year and last are as follows: Industrial buildings, 266 and 125; commercial buildings, 846 and 705; unclassified construction, 304 and 120.

The unclassified group includes piers, transmission lines, tunnels, playgrounds, boardwalks, stadiums, grain elevators, power developments, subways. May contracts for this group amounted to $50,000,000 compared with $22,000,000 in May, 1928.

SIX JOBS FOR JUNE BIDDING

Job	In Charge	Size or Cost	Bids Asked
Dredging	U. S. Engines, New Orleans	10,875,000 yd.	June 27
Levee	U. S. Engineers, Vicksburg	5,400,000 yd.	June 17
Ammunition depot	Yards & Docks, Washington	131 buildings	June 26
Concrete paving	Highway Commission, Baton Rouge	81.75 mi.	June 25
Concrete bridge	Rollins & Clinger, Dallas	2,900 x 60 ft.	June 20
Museum	Graham, Anderson, Probst & White, Chicago	$5,000,000	June 19

Materials Markets Busy Supplying Heavy Construction Needs

Current lumber demand has two distinct phases. Large jobbers in heavy structural material such as that used on engineering projects report a steady increase in consumption good for the next sixty days. Small dealers who stock material for frame residences, report business below last year's volume at this season.

The tendency to raise prices of pine and fir timbers in view of the active demand is being counteracted by lowered shipping costs resulting from a rate war among carriers of water-borne freight. In the last month 3x12's (20 ft.) advanced $1 ($52) at Boston; $1 ($23.50) at Seattle; and $6 ($44) at Los Angeles. Pine 3x12's rose $7 ($62) at Philadelphia.

Steel Orders Heavy—The Pittsburgh mill base on steel reinforcing bars is up 5c. to $2.05. Steel plates and shapes hold firmly at $1.95 on practically all current transactions. The tendency to shade the mill base, which was noticeable a month ago, has disappeared from the market. It is expected that the current price will carry over into the third quarter. Mill bookings continue heavy.

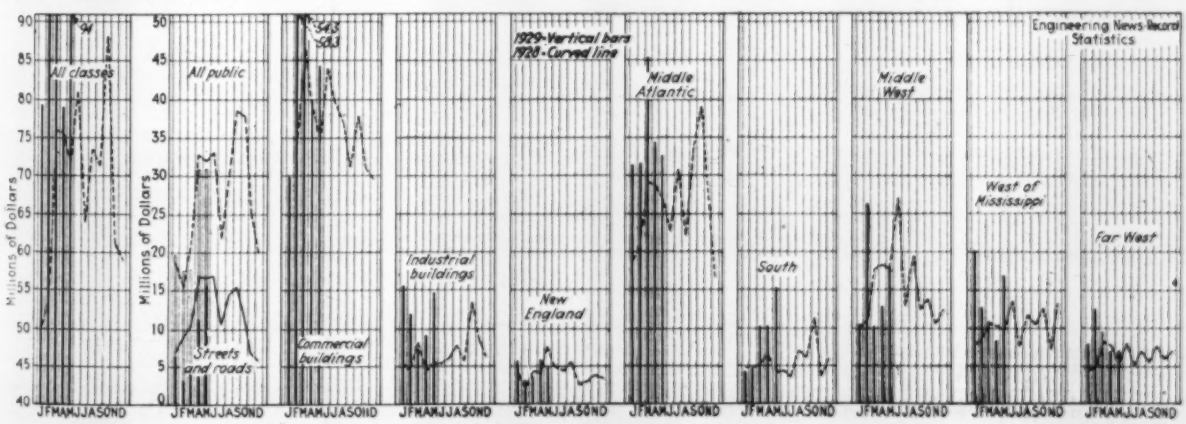
Current pig iron prices illustrate the steel situation—Southern foundry iron tends downward, while the basic or steel-making grade is headed up. The minimum on No. 2 foundry, Southern, Birmingham, is $15 as against $15.50 last month, while basic iron at Pitts-

VALUE OF CONTRACTS BY SECTIONS IN THE UNITED STATES AND TOTAL FOR CANADA, MAY, 1929

Thousands of Dollars (000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States May, 1929	United States Jan. 1 to Date	Canada May, 1929
Water-works	$896	$3,043	$251	$657	$319	$318	$5,484	$18,785	$797
Sewers	58	3,419	1,461	5,051	856	880	11,725	36,466	115
Bridges	352	6,723	4,758	5,307	3,975	100	21,215	60,833	507
Excavations, etc.	13	147	611	192	329		1,292	16,021	78
Streets and roads	5,509	21,246	9,880	19,549	16,718	5,382	78,284	183,462	1,109
Industrial buildings	1,692	5,897	15,330	11,606	34,434	5,341	74,300	265,572	5,315
Commercial buildings	15,984	116,424	3,676	46,525	23,935	14,349	220,873	980,048	5,252
Federal government	102	2,600	3,641	63	2,102	400	8,908	44,680	
Unclassified	448	2,196	35,954	1,301	2,105	7,524	49,528	303,883	3,819
May, 1929*	25,054	161,695	75,562	90,251	84,773	34,274	471,609		16,992
April, 1929†	23,027	138,376	42,043	51,605	33,166	27,992	316,209		16,287
May, 1928*	36,903	134,896	20,445	89,537	48,916	26,362	357,059		13,329
Year to date, 1929	102,618	764,051	198,584	339,816	314,089	190,602		1,909,760	72,274
Year to date, 1928	102,471	552,507	109,729	338,891	211,169	135,815		1,450,582	64,051

*Five weeks. †Four weeks.



CONTRACTS AWARDED—AVERAGE WEEK PER MONTH—TOTAL U. S. BY CLASSES—ALL CLASSES BY SECTIONS

burgh is $20.26 compared with $19.26 per ton in May.

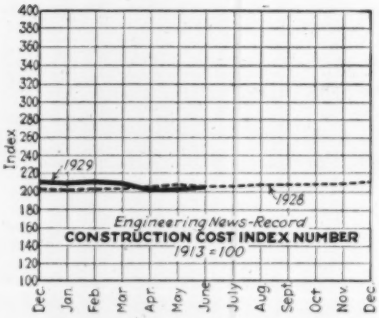
Alabama ironmakers are optimistic over a freight rate reduction on pig-iron shipments to the Atlantic seaboard, effective July 1, 1929. These reductions will range from $0.71 to $1.16 per ton on iron going to Baltimore, Philadelphia, New York and Boston. The new rates will continue in force until March 31, 1930, as an experiment. This action was taken by the Central of Georgia Railroad in an effort to relieve surplus iron stocks in the Birmingham district and also to enable Alabama producers to compete with makers of foreign iron coming in through North Atlantic ports. There are approximately 150,000 tons of iron in Birmingham yards, which is called excessive.

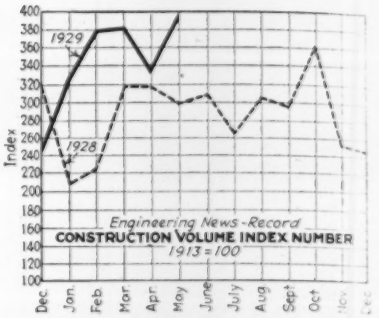
Heavier demand for Southern iron is expected during June due to large orders for cast-iron pressure pipe. The United States Pipe & Foundry Company will soon reopen an old pipe foundry which has long been closed.

Cast-iron pipe prices remain the same as they were a month ago. The mill base on 6-in. is still $38 in both Birmingham and Burlington foundries. The official quotation of $46.20 per ton for 6-in. and over at Chicago checks closely with a contract price of $46.45 for 770 tons of 24-in.

Cement prices declined at two Southern mills and two Western f.o.b. points. The mill declines were as follows: North Birmingham 10c. ($1.35); Richard City, Tenn., 15c. ($1.70). The carload price f.o.b. Cincinnati was reduced 5c. ($2.17), and that at Cleveland 10c. ($2.14). Manufacturers expect agricultural interests in Congress to oppose the tariff of 8c. per 100 lb.

Brick Market Weak—Some twenty manufacturers who were producing brick last year in the Hudson Valley have closed their plants, claiming that it will be unprofitable for them to produce unless the price of brick advances.





ENGINEERING NEWS-RECORD CONSTRUCTION COST AND VOLUME INDEX NUMBERS

Common brick manufacturers believe it highly probable that this year's production in the Hudson River district will fall somewhere between 250,000,000 and 300,000,000 short of the quantity produced in 1926, 1927 and 1928.

Construction Cost and Volume Index Numbers

E. N.-R. Cost		E. N.-R. Volume*	
June, 1929	**205.65**	**May, 1929**	**395**
May, 1929	205.15	Apr., 1929	332
June, 1928	206.15	May, 1928	299
Peak June, 1920	273.80	1928 (average)	287
1928 (average)	206.78	1927 (average)	263
1913 (average)	100.00		
1928		1928	
January	203.90	January	208
February	204.65	February	225
March	204.65	March	318
April	206.40	April	316
May	207.00	May	299
June	206.15	June	308
July	206.65	July	266
August	207.29	August	306
September	207.29	September	296
October	207.71	October	363
November	209.46	November	251
December	210.16	December	244
1929		1929	
January	209.40	January	325
February	210.40	February	378
March	207.78	March	382
April	203.40	April	332
May	205.15	May	395

*Corrected for price change since 1913.

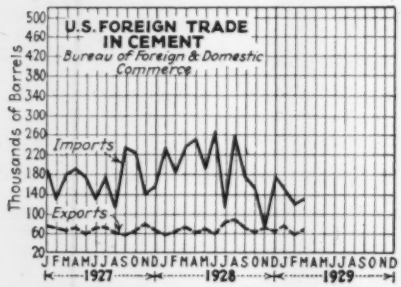
Brick at Boston declined 25c. ($16.75) and at Dallas $1 ($13.50). There were no advances. Brick makers are awaiting with interest the reaction of the agricultural block in Congress to the proposed tariff of $1.25 per thousand of common brick, now duty free.

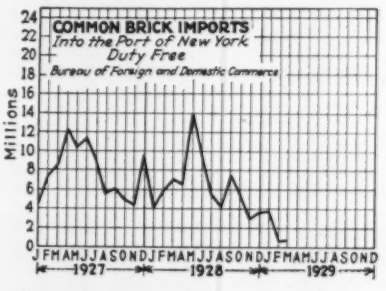
Short Week Nearer in Building Industry

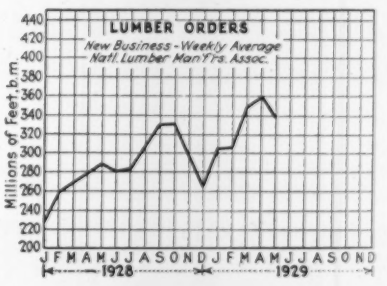
The five-day week is unmistakably the goal of building labor, as representing the most effective means of preventing unemployment. Wage advances of 10 per cent accompany the 40-hr. week agitation in most cases.

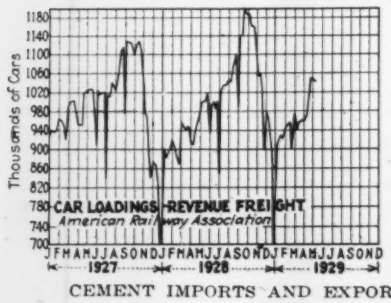
The tangled building trades situation in New York is part of this nation-wide movement toward the five-day week and had its origin in a strike of electrical workers against three contractors who are members of the Building Trades Employers' Association.

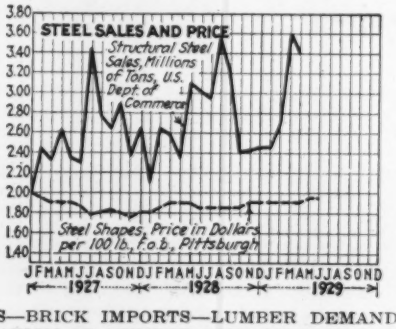
All differences, however, which exist between New York contractors and building labor unions, in a dispute which threatened for a while to cause a complete tie-up of construction in this city, are to be arbitrated. This agreement has been arranged through Supreme Court Justice Crain.

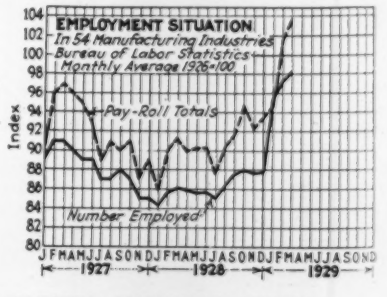

U.S. FOREIGN TRADE IN CEMENT
Bureau of Foreign & Domestic Commerce
Thousands of Barrels
Imports
Exports
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929


COMMON BRICK IMPORTS
Into the Port of New York
Duty Free
Bureau of Foreign and Domestic Commerce
Millions
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929


LUMBER ORDERS
New Business - Weekly Average
Natl. Lumber Manf'rs. Assoc.
Millions of Feet, b.m.
J F M A M J J A S O N D J F M A M J J A S O N D
1928 1929


CAR LOADINGS - REVENUE FREIGHT
American Railway Association
Thousands of Cars
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929


STEEL SALES AND PRICE
Structural Steel Sales, Millions of Tons, U.S. Dept. of Commerce
Steel Shapes, Price in Dollars per 100 lb., f.o.b., Pittsburgh
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929


EMPLOYMENT SITUATION
In 54 Manufacturing Industries
Bureau of Labor Statistics
Monthly Average 1925-100
Index
Pay-Roll Totals
Number Employed
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929

CEMENT IMPORTS AND EXPORTS—BRICK IMPORTS—LUMBER DEMAND—FREIGHT MOVEMENT—STEEL DEMAND—RELATION OF NUMBER EMPLOYED TO TOTAL PAYROLL

CURRENT BUILDING AND CONSTRUCTION TRADES WAGE RATES PER HOUR

Advances since last month are indicated by **heavy type**; declin s by *italics*

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor*
Atlanta	$1.25@1.40	$0.60@ .70	$0.60@1.00	$0.50	.....	$0.75@1.25	$0.25@.35
Baltimore	1.62@1.75	1.00@1.10	1 37½	1.00	$0.65	1.00@1.25	.35
Birmingham	1.50	1.00	1.25	.50	.....	1.75	.20@.35
Boston	1.50	1.37½	1.37½	.85	1.27½	1.37½	.45@.80
Cincinnati	1.62½	1.37½	1.37½	.97½	1.37½	1.37½	.40@.60
Chicago	1.62½	**1.56¼**	**1.56¼**	.90	**1.56¼**	1.50	.90
Cleveland	1.62½	1.37½	1.37½	.87½	1.10	1.50	.40@.87½
Dallas	1.67½	1.12½	1.25	.35 @ .75	1.25	1.25	.35 @.50
Denver	1.50@1.62½	1.25	1.25@1.37½	.87½@1.00	.....	1.25	.37½@.62½
Detroit	1.56¼	1.00@1.25	1.00@1.10	.90	1.00@1.10	1.00@1.25	.37½@.60
Kansas City	1.50	1.25	1.25	.90	1.25	1.25	.30@.75
Los Angeles	1.25	1.00	1.00	.87½	.....	1.00	.50
Minneapolis	1.25@1.37½	.87½@.95	.87½	.75	.....	1.00	.40@.60
Montreal	1.25	**.80**	.75	.40	.....	**1.00**	.30@**.35**
New Orleans	1.50	.90	1.25	.75	.80@1.00	1.25	.30@.40
New York	1.87½	1.50	1.75	1.12½	1.00@1.12½	1.75	.90½
Philadelphia	1.62½	1.12½@1.25	1.02½	.70@1.12½	1.00	1.37½@1.50	.45@.50
Pittsburgh	1.70	1.50	1.43¾@1.56¼	1.12½	.....	1.50	.40@.80
St. Louis	1.75	1.50	1.50	1.15@1.25	1.25	1.50	.40@.75
San Francisco	1.37½	1.12½	1.12½	.87½	1.12½	1.37½	.50@.60
Seattle	1.50	1.12½	1.25	1.00	1.12½	1.25	.70

*Minimum rates are for construction other than buildings, non-union.

With volume of new contracts at record levels and costs slightly under those of a year ago, serious unemployment becomes a local problem, as at Chicago, Philadelphia, St. Louis and to a slighter extent, Cleveland, Dallas and Minneapolis.

Chicago employers say "there has not been a spring for the past eight years which showed so little activity on new buildings as the present one." Painters have been granted the five-day week with no increase in wages. Carpenters are to receive an advance of 6½c. per hour ($1.56¼) and closed-shop conditions but without the five-day week. Plasterers are negotiating for a wage advance to make up for the salary loss resulting from the five-day week. A jurisdictional dispute between steamfitters and plumbers threatens a tie-up of work on several buildings. Structural ironworkers went on strike June 1 for a wage advance of $1 per day ($13) followed by the ornamental ironworkers who demand the same rate. Bricklayers have been granted a wage increase of 7½c. per hour ($1.70) effective Oct. 1, 1929.

Unemployment in Philadelphia building trades is still acute but bricklayers will receive an advance and the five-day week. Electricians demand an advance of 25c. per hour. A small strike of carpenters arose out of a demand for double pay for all overtime.

St. Louis stonecutters, structural ironworkers and building laborers went on strike in May, tying up new construction worth $15,000,000. The stonecutters and ironworkers demand an increase of 25c. ($1.75), while the laborers want a flat scale of 90c. per hour as against the old rate of 75c. for pick-and-shovel men and 87½c. per hour for concrete workers. The stonecutters returned to work May 24 at the old scale and under former conditions. The other crafts are conducting negotiations tending toward an early settlement.

New Haven carpenters won their strike started May 1, with a wage advance of $1 per day ($10) but in doing so relinquished demands for the five-day week.

Providence experienced a small strike during May, when men of various crafts walked out in protest against the open shop.

Poughkeepsie plumbers who were on strike from May 2 to 26 have returned under a compromise granting an increase of 50c. per day ($10.50) and the five-day week. Schenectady and Kingston plumbers are on strike in an effort to obtain a wage advance of $2.80 per week ($60) and the five-day schedule.

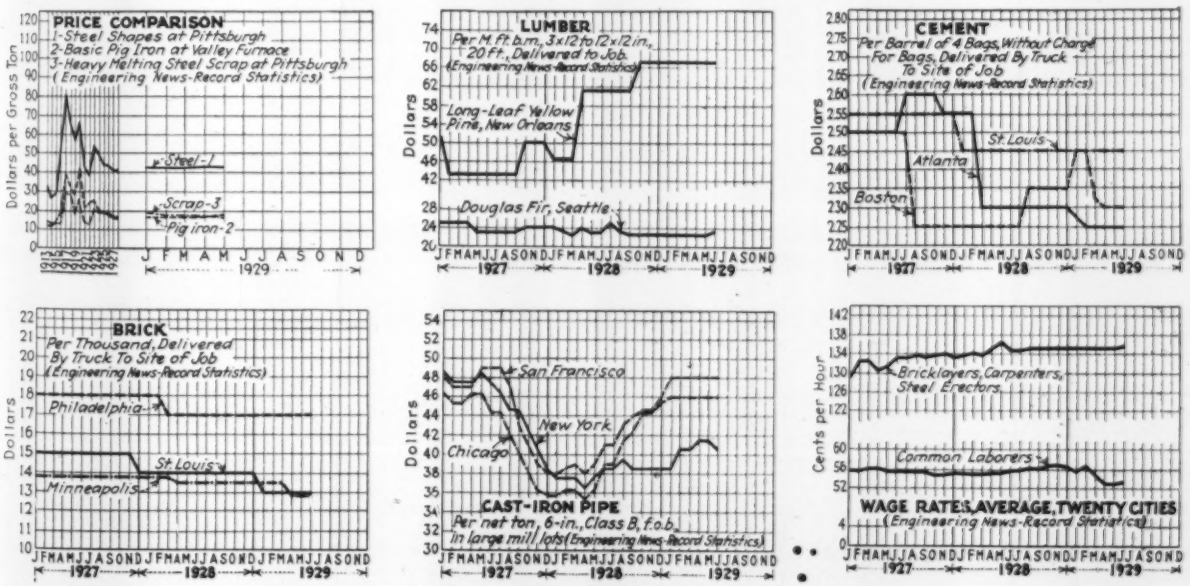
Syracuse electricians staged a minor strike during May, in protest against hiring of non-union mechanics on a local job. The strike of electricians, however, led to a lock-out and finally to a general strike of all building crafts in the city.

Plainfield carpenters went on strike during May, for a wage advance of 10c. per hour ($1.50) and the five-day week. The employers are willing to agree to the shorter week but refuse to make the proposed wage increase. The plumbers, who have been on strike also, returned to work under an agreement granting the five-day week. Painters in the Perth Amboy district went on strike demanding a wage increase of $2 per day ($10) and the five-day week.

Wage changes are slightly upward in both skilled and unskilled rates, compared with May levels, throughout the United States.

The national rate for common labor is 53.4c. per hour, compared with 53.15c. a month ago and 55.5c. in June, 1928. The average common labor rate in manufacturing is 50.3c.

The average skilled labor rate is $1.35¾ as against $1.35¼ a month ago and $1.34¾ in June, 1928. The average skilled rate in manufacturing is 67.3c.



PRICES OF CONSTRUCTION MATERIALS AND WAGES OF LABOR

Current Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

Building Materials

PORTLAND CEMENT—Prices per bbl., quoted by manufacturers and dealers, delivered by trucks to contractors, *without charge for bags*. Cash discount not deducted.

	June 6, 1929	One Month Ago	One Year Ago
Atlanta	$2.25	$2.25	$2.30
Baltimore	2.65	2.65	2.65
Birmingham	2.60	2.60	2.60
Boston	2.25@2.35	2.25@2.35	2.25
Cedar Rapids (f. o. b.)	2.24	2.24	2.24
Chicago (f. o. b.)	2.05	2.05	2.05
Cincinnati (f. o. b.)	*2.17*	2.22	2.22
Cleveland (f. o. b.)	*2.14*	2.24	2.24
Dallas	2.15	2.15	2.40
Davenport (f. o. b.)	2.24	2.24	2.24
Denver	2.55	2.55	2.85
Detroit (f. o. b.)	1.95	1.95	1.90
Duluth (f. o. b.)	2.04	2.04	2.04
Indianapolis, (f. o. b.)	2.09	2.09	2.19
Jersey City	2.25	2.25	2.35
Kansas City, Mo.	2.55	2.55	2.40
Los Angeles	2.76	2.76	2.66
Milwaukee (f. o. b.)	2.20	2.20	2.20
Minneapolis (f. o. b.)	2.22	2.22	2.22
Montreal (f. o. b.)	1.70	1.70	1.41
New Orleans	2.65	2.65	2.40
New York	2.25	2.25	2.25@2.35
Peoria (f. o. b.)	2.22	2.22	2.22
Philadelphia	2.40	2.40	2.31@2.41
Pittsburgh (f. o. b.)	2.05	2.05	2.04
St. Louis	2.45	2.45	2.45
St. Paul (f. o. b.)	2.22	2.22	2.22
San Francisco	2.41	2.41	2.41
Seattle	2.70	2.70	2.70
Toledo (f. o. b.)	2.20	2.20	2.20

Current mill-prices per barrel, in carloads, without bags, f.o.b.:

Alpena, Mich.	$1.65	Lehigh Valley District	$1.75
Buffington, Ind.	1.80	Mason City, Ia.	1.80
Clinchfield, Ga.	1.65	Mitchell, Ind.	1.90
Fordwick, Va.	2.05	North Birmingham, Ala.	*1.85*
Hannibal, Mo.	1.90	Richard City, Tenn.	*1.70*
Hudson, N. Y.	1.75	Steelton, Minn.	1.85
Iola, Kan.	1.85	Universal, Pa.	1.80
La Salle, Ill.	1.90	Wyandotte, Mich.	1.70
Leeds, Ala.	1.65		

SAND AND GRAVEL—Dealers' quotations per cu.yd. delivered. Weight of sand, 1½ tons per cu.yd.; gravel, 1½ tons per cu.yd., unless otherwise specified in pounds.

	Gravel		Sand
	1½ In.	¾ In.	
Atlanta, per ton	$3.50	$3.50	$2.40
Baltimore, per ton	2.40	2.60	1.70
Birmingham (2,600 lb.)	3.00	3.00	2.65
Boston, per ton	1.90	1.90	1.25
Chicago	*1.90*	*1.90*	*1.90*
Cincinnati, per ton	1.90	1.90	1.60
Cleveland	2.60	2.60	2.50
Dallas	**2.60**	**2.60**	2.25
Denver (2,700 lb.)	1.80	1.80	1.30
Detroit (2,600 lb.)	3.25	3.25	2.75
Kansas City, Mo.	.....	.....	.....
Los Angeles, per ton	2.15	2.15	1.30
Minneapolis (2,800 lb.) (3,000 lb.)	2.40	2.40	1.10
Montreal, per ton	1.90	1.50	1.20
New Orleans (2,700 lb.) (2,500 lb.)	3.75	3.75	2.75
New York	3.25	3.25	2.00
Philadelphia, per ton	2.30@3.15	2.30@3.15	1.50@2.31
Pittsburgh, per ton	**3.05**	**3.05**	**2.75**
St. Louis, per ton	2.25	2.25	2.00
San Francisco (2,800 lb.)	1.75	1.75	1.50
Seattle (3,200 lb.) (2,850 lb.)	1.75	1.75	1.75

Note: New York gravel weighs 2,800@3,000 lb. and sand, 2,700 lb.

CRUSHED STONE—Dealers' quotations per cu.yd., delivered. Weight, 1½ tons per cu.yd., unless otherwise specified in pounds:

	1½ In.	¾ In.
Atlanta, per ton	$3.50	$3.50
Baltimore, per ton	2.75	2.85
Birmingham, Limestone	3.00	3.25
Boston, per ton	2.25	2.25
Chicago, Limestone	*1.90*	*1.90*
Cincinnati, per ton	2.50	2.50
Cleveland, per ton	2.70	2.70
Dallas	3.25	3.40
Denver, Granite (2,700 lb.)	2.50	2.50
Detroit, Limestone, per ton	3.00	3.00
Kansas City, Limestone, per ton, at plant	2.00	2.00
Los Angeles, per ton	2.15	2.15
Minneapolis, Limestone (2,600 lb.)	2.40	2.40
Montreal, per ton	2.10	2.10
New York, Limestone	3.25	3.25
Philadelphia, Limestone, per ton	2.30@3.15	2.30@3.15
Pittsburgh, per ton	3.25	3.25
St. Louis, per ton (2400 lb. per cu.yd.)	**1.95**	**1.95**
San Francisco, Trap rock (2,400 lb.)	1.65	1.65
Seattle, (2,700 lb.)	1.90	1.90

CRUSHED SLAG—Manufacturers' quotations on crushed slag in carloads, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Sand
Birmingham, Ala.	$0.90	$1.15	$2.05	$0.55
Buffalo District	1.25	1.35	2.25	1.25
Cleveland, Ohio	1.30	1.30	.....	1.30
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Youngstown District	1.30	1.40	2.00	1.30

HOLLOW TILE—Dealers' quotations on hollow building tile per block, delivered to contractors in lots of 2,000 pieces or over:

	4x12x12	6x12x12	8x12x12	10x12x12	12x12x12
Atlanta	$0.075	$0.104	$0.142	$0.189	$0.21
Baltimore	105	.....	.20	.....	26
Birmingham	.09	.127	.174	.218	.261
Boston	.085	.11	.15	.1875	.235
Chicago	.076	.104	.142	.182	.202
Cincinnati	.074	.105	.136	.175	.205
Cleveland	.064	.088	.128	.171	.19
Dallas	.096	*.1185*	*.1725*	*.26*	.....
Denver	.0975	.135	.175	.2125	.25
Detroit	.096	.132	.18	.235	.261
Kansas City	.0525	.077	.158	.....	.242
Los Angeles	.085	.122	.175	.232	.285
Minneapolis	.0675	.0845	.131	.134	.1896
Montreal	.12*	.....	.22†	.....	.....
New Orleans	.086	118	.16	.212	.256
New York	.0864	.1296	.162	.....	.....
Perth Amboy, N.J. (f.o.b.)	.....	.....	.....	.2388	.2956
Philadelphia	*.105*	*.14*	*.215*	**.28**	.34
Pittsburgh	.068	.....	.1175	.....	.1726
St. Louis	.078	*.104*	.145	.175	.21
San Francisco	.108	.156	.255	.....	.....
Seattle	**.085**	**.115**	.18	.....	.....

*4x4x12. †8x8x12.

BRICK—Dealers' quotations, delivered, per thousand are as follows:

		Paving	
	Common	3x8½x4-in.	3½x8½x4-in.
Atlanta	$14.75	$38.00*	$45.00†
Baltimore	14.00	40.00	46.00
Birmingham	15.00	30.00*	34.00†
Boston	*16.75*	*43.00*	48.50
Chicago	12.00	42.00	45.00
Cincinnati	18.00	40.00	45.00
Cleveland	14@16	33.00	36.00
Dallas	*13.50*	35.00	.....
Denver, salmon	12.00	.....	.....
Detroit	15.50	34.14	38.27
Kansas City	14.00	.....	.....
Los Angeles	11.00	.....	.....
Minneapolis	12.75	.....	.....
Montreal	20.33	.....	.....
New Orleans	16.50	40.00*	50.50
New York	15@16	45.00	51.00
Philadelphia	17.00	40.00	46.00
Pittsburgh	17.00	40.50	45.00
St. Louis, salmon	13.00	40.00	42.50
San Francisco	14.50	40.00	45.00
Seattle	14.00	50.00	55.00

*2½x8½x4 in. †3x8½x4.

LIME—Dealers' quotations, delivered to job:

	Hydrated, per Ton		Lump, per Barrel	
	Finishing	Common	Finishing	Common
Atlanta	$27.50	$17.50	.....	.....
Baltimore	20.00	14.00	$2.55†	.....
Birmingham	22.00	16.00	3.00†	$2.00†
Boston	21.00	14.50	3.80*	2.90*
Chicago	**18.00**	*14.00*	**18.00‡**	*1.35†*
Cincinnati	18.00	13.20	.....	13.20‡
Cleveland	20.00	16.00	2.50†	2.50†
Dallas	20.00	.....	.....	18.00‡
Denver	32.00	23.75	3.80*	3.00*
Detroit	19.20	14.80	2.20†	2.20†
Kansas City	15.00	12.50	.....	2.75†
Los Angeles	25.00	18.00	2.85†	17.00‡
Minneapolis	25.50	21.00	.....	1.70†
Montreal	19.75	.....	.....	15.00‡
New Orleans	.....	.....	2.60†	1.60†
New York	21.00@22.00	14.00@15.00	4.00@4.10*	3.15@3.25*
Philadelphia	22.00	15.00	.....	.....
Pittsburgh	20.00	18.00	.....	.....
St. Louis	24.00	18.00	2.75†	15.00‡
San Francisco	27.50	20.00	.....	1.70†
Seattle, paper sacks	36.00	24.00	.....	2.80†

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡Per ton.

CONCRETE BLOCKS—Manufacturers' quotations on standard, 8x8x16-in., hollow, delivered to job, each:

Boston	$0.18@.20	Minneapolis, f.o.b.	$0.13
Brooklyn and Queens	.14@.16	New Orleans	.22
Cleveland	.16@.17	Philadelphia	.18@.25
Denver	.22	Pittsburgh	.20
Detroit	.15	St. Louis	.18

SLATE—Roofing, genuine Bangor, f.o.b., quarry, Bangor, Pa., per square:

No. 1 Clear	$10.50@$14.00
No. 1 Ribbon	9.00@10.25
Medium Clear	9.50@11.25

Road and Paving Materials

PAVING STONE—Dealers' quotations, f.o.b., in carloads or in cargo lots, for granite blocks, 4x8x4-in., dressed:

Atlanta	$3.00 per sq.yd.
Baltimore	3.00 per sq.yd.
Boston	135.00 per M.
Chicago, 5 in.	3.25@3.90 per sq.yd.
Cincinnati	110.00 per M.
Cleveland	115@120 per M.
Detroit, 5 in.	3.00 per sq.yd.
Kansas City	3.50 per sq.yd.
Minneapolis, Sandstone, 4½x8x5 in.	2.80 per sq.yd.
Montreal	104.75 per M.
New Orleans	2.80 per sq.yd.
New York, 5 in., Grade 1, 30 blocks per sq.yd.	150.00 per M.
Philadelphia	125.00 per M.
St. Louis, 4x5x8 to 12 in.	3.50 per sq.yd.
San Francisco, Basalt block, 4x7x8 in.	70.00 per M.

Current Prices of Construction Materials

Road and Paving Materials—Continued

WOOD-BLOCK PAVING—Dealers' quotations, f.o.b., in carloads:

	Size of Block	Treatment	Per Sq.Yd.
Atlanta	3½	16	$2.25
Boston	3½	16	2.45
Chicago	3½	12	2.10
Cincinnati	3½	16	2.35
Dallas	3½	18	3.90
Kansas City	3½	16	2.50
Minneapolis	3½	16	2.75
Montreal	4	16	4.50
New Orleans	3½	16	**2.50**
New York	3½	16	2.70
St. Louis	3½	16	*2.30*

FLAGGING—Dealers' quotations, alongside dock, New York: Manhattan and Bronx, 4 ft. wide, 24c. per sq.ft.; Queens, 5 ft. wide, 26c. per sq.ft.

CURBING—Dealers' quotations: *New York*: Bluestone, f.o.b. barge, New York, 5x16 in., rough, 90c. per lin.ft., cutting charges extra. *Birmingham*: Limestone, 5x18-in., f.o.b., $1.05 per lin.ft. *St. Louis*: Class "B" straight, 5x16 in., f.o.b., *$1.00* per lin.ft.; roundings, *$1.50* per lin.ft.

ASPHALT—Manufacturers' quotations per ton in packages (350-lb. bbls. or 425-lb. drums); also in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
Atlanta (Mexican)	$22.55	$18.40
Baltimore (Standard Oil, f.o.b. refinery)	21.75	17.75
Birmingham (Mexican)	27.00	23.00
Boston (Mexican)	24.00	18.00
Chicago (Texas)	*23.50*	*19.30*
Cincinnati (Kentucky Rock)	.....	12.30
Cleveland	24.00	20.00
Dallas (Texas)	24.68	.....
Denver (California)	35.00	.....
Detroit (Mexican)	19.72	15.69
Kansas City, Mo. (Texas)	25.30	20.30
Los Angeles ("D" Grade, California, f.o.b., El Segundo)	18.00	12.00
Maurer, N. J. (Bermudez)	30.00	.....
Maurer, N. J. (Trinidad)	25.00	.....
Minneapolis, (Stanolind, f.o.b., Twin Cities)	24.10	19.10
Montreal (Imperial)	28.00	21.50
New Orleans (Texas)	24.00	21.00
New York (Texas)	22.50	18.50
Philadelphia (Mexican)	*18.00*	*15.00*
Pittsburgh (Standard Oil)	**18@20**	**16@18**
St. Louis (Mexican)	21.50	17.50
San Francisco, (f.o.b. refinery, Oleum, Calif.)	18.00	12.00
Seattle, ("D" grade, California, f.o.b., Richmond refinery)	19.50	13.50

ROAD OILS—Manufacturers' quotations, f.o.b., in tank cars, 8,000 gal. minimum, per gal.:

Birmingham, 40@50% asphalt	$0.0525
Birmingham, 50@60% asphalt	.0525
Dallas, 40@50% asphalt	**.06½**
Dallas, 50@60% asphalt	**.06½**
New York, 40@50% asphalt. (at terminal)	.06
New York, 50@60% asphalt. (at terminal)	.06
St. Louis, 40@50% asphalt	.0342
St. Louis, 50@60% asphalt	.0357

Iron and Steel

PIG IRON—Producers' quotations, per gross ton, f.o.b.:

Birmingham, No. 2 fdry., silicon 1.75@2.25	$*15.00*@$15.50
Pittsburgh, basic, incl. freight ($1.76) from Valley	**20.26**

STRUCTURAL STEEL—Manufacturers' and dealers' quotations per 100 lb.:

	Shapes, 3 to 15-In.	Plates, ¼-In
Birmingham, large mill lots, f.o.b.	$2.15	$2.15
Chicago, warehouse, delivered	3.10	3.10
Cleveland, warehouse, delivered	3.00	3.00
Dallas, warehouse, delivered	**3.60**	**3.60**
New York, warehouse, delivered, up to 3,999 lb.	3.30	3.30
Pittsburgh, large mill lots, f.o.b., (May 30, 1929)	1.95	1.95
St. Louis, warehouse, delivered	3.25	3.25
San Francisco, warehouse, delivered	3.15	3.15

BARS, CONCRETE REINFORCING—Manufacturers' and dealers' quotations on bars rolled from billets, per 100 lb. for ½-in.:

Birmingham, large mill lots, f.o.b.	$2.15
Chicago, warehouse, delivered	2.30@3.00
Cleveland, warehouse, delivered	2.25@2.44
Dallas, warehouse, delivered	**3.70**
New York, warehouse, delivered, over 5 tons	2.90
Pittsburgh, large mill lots, stock lengths, f.o.b.	**2.05**
St. Louis, warehouse, delivered	3.15
San Francisco, warehouse, delivered	2.25

EXPANDED METAL LATH—Dealers' quotations per 100 sq.yd., painted, delivered to job in less-than-carload lots:

Lb. per Sq. Yd.	New York	Birmingham	Chicago	St. Louis	Dallas	San Francisco
2.2	$13.50@$15.00	$22.00	$20.50	*$18.00*	$23.50	$24.50
2.5	14.50@16.00	23.00	21.50	*19.00*	25.00	25.50
3.0	16.00@17.00	25.00	23.00	*21.00*	27.00	28.00
3.4	18.00@18.50	26.50	24.00	*22.50*	28.50	30.00

WIRE REINFORCEMENT FOR CONCRETE—Manufacturers' quotations per 100 sq.ft. in carloads at mills; and dealers, delivered in lots of 10,000 sq.ft. or over; plain 4 in. by 4 in. mesh:

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse Delivery: New York	St. Louis	Dallas*	San Francisco*
032	22	$0.99	$1.01	$1.39	$1.30	$1.13	$1.22
049	28	1.26	1.29	1.76	1.70	1.38	1.55
068	35	1.54	1.58	2.18	2.10	1.67	1.91
093	40	1.98	2.03	2.79	2.65	2.00	2.46
126	57	2.45	2.51	3.45	3.30	2.55	3.03
153	68	2.92	2.99	4.13	3.95	3.15	....
180	78	3.35	3.43	4.73	4.50	3.47	....

*At warehouse.

STEEL SHEETS—Manufacturers' and dealers' quotations per 100 lb., base size

	Blue Annealed No. 10	Black No. 24	Galvanized No. 24
Chicago, warehouse, delivered	$3.35	**3.05**	**3.90**
Cleveland, warehouse, delivered	3.25	**3.90**	**4.75**
New York, warehouse, delivered	3.90*	4.00	4.75
Pittsburgh, large mill lots, f.o.b.	**2.35**	*2.85@2.95*	*3.60@3.70*
St. Louis, warehouse, delivered	3.45	4.25	5.10
San Francisco, warehouse, delivered	3.80	4.90	5.30

*Up to 3,999 lb.

WIRE ROPE—Discounts from manufacturers' list price on regular grades of bright and galvanized, Eastern Territory, New York, and East of Missouri River:

	Base
Cast steel round strand rope	20%
Galvanized iron rigging and guy rope (add to list)	12½%
Galvanized steel rigging and guy rope	7½%
Plow steel round strand rope	35%
Round strand iron and iron tiller	5%
Special steel round strand rope	30%

Discount 5 points less than discount for Eastern territory: California, Oregon, Nevada, Washington, Wyoming, New Mexico, Colorado, North Dakota, Nebraska, Kansas, Oklahoma and Texas. Discount 10 points less than discount for Eastern territory: Arizona, Montana, Idaho and Utah.

RIVETS—Manufacturers' and dealers' quotations on structural rivets, round-head, ½-in., full kegs, per 100 lb.:

Chicago, warehouse, delivered	**$4.00**
Dallas, warehouse, delivered	**4.90**
New York, warehouse, delivered	4.50*
Pittsburgh, large mill lots, f.o.b.	3.10
St. Louis, warehouse, delivered	3.95
San Francisco, warehouse, delivered	5.75
Seattle, warehouse, delivered	**5.50**

*This price is for full kegs; broken kegs are $6.00 per 100 lb.

STEEL SHEETPILING—The manufacturers' base price, f.o.b., Pittsburgh, for large mill lots is $2.25 per 100 lb.

TERNE PLATE—I C, 8-lb. coating, 20x28-in., f.o.b., Pittsburgh mill:

Per package	$11.20

SHIP SPIKES—Dealers' quotations per 100 lb., black, from warehouse stocks; galvanized are about $1.75 per 100 lb. higher:

	½-In.	⅝-In.	¾-In.
San Francisco	$5.55	$5.10	$4.95
Seattle	7.75	5.65	5.50

Pittsburgh mill base in lots of 200 kegs or more, $3.00 per 100 lb.

WIRE NAILS—Dealers' quotations per 100 lb. keg, base, delivered from warehouse stocks, also Pittsburgh mill base:

Pittsburgh Mill	Birmingham	Chicago	St. Louis	Dallas	San Francisco	Montreal
$2.75	$3.30	$3.20	*$3.05*	$3.75*	$3.35*	$4.95

SCRAP—The prices following are, f.o.b., per ton, paid by dealers:

	New York Per Gross Ton	Chicago Per Gross Ton	Detroit Per Gross Ton
No. 1 railroad wrought	*$12.00*@$12.50	*$15.75*@$16.25	$15.00
Stove plate	*7.75@9.00*	*14.00@14.50*	10.50@11.00*
No. 1 machinery cast	15.00@17.00	*17.00@17.50*	*12.00**
Machine shop turnings	*7.25@7.50*	*7.50@8.00*	*7.25*
Cast borings	7.00@7.25	*10.00@10.50*	**9.50**
Railroad malleable	14.00@14.50	*18.00@18.50*	**14.00**
Re-rolling rails	*13.00@13.50*	17.50@18.00	*15.00*
Re-laying rails, 56@60 lb.	23.00@24.00	23.00@25.00	.....
Heavy melting steel, No. 1	*12.00@13.00*	*15.25@15.75*	14.50
Iron and steel pipe	*11.25@11.75*	*10.50@11.00*	**8.75@10.50**

*Net ton.

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant-steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carload lots of 36,000 lb. or 18 tons:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.71*
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15†
Chicago	.34	Philadelphia	.32
Cincinnati	.27	St. Louis	.405
Cleveland	.19	St. Paul	.60
Denver	1.15†		

*Except iron or steel pipe and fittings. †Minimum weight on structurals, 60,000 lb.

Railway Materials and Supplies

STEEL RAILS—Manufacturers' quotations per gross ton, f.o.b., for large mill lots:

	Pittsburgh	Birmingham	Chicago
Standard openhearth rails	$43.00	$43.00	$43.00
Light rails, 25 to 45 lb.	36.00	34@36	34@36
Re-rolled rails	34@36	34@36	34@36

RAILWAY TIES—Dealers' quotations, f.o.b., for fair-sized orders:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
New York	Long-leaf sap pine, untreated	$1.10	$1.30
	Creosoted—prices on application.		
Birmingham	Southern pine, untreated	1.10	1.25
	Southern pine, creosoted	1.60	1.75
Chicago	White oak, untreated	1.40	1.78
	Oak, empty cell, creosoted	1.80	2.40
	Oak, zinc treated	1.60	2.10
	Southern pine, creosoted	1.60	2.10
St. Louis	White oak, untreated	**1.13**	1.60
	Red oak, creosoted	*1.43*	**2.05**
	Sap pine or cypress, untreated	*.88*	*1.20*
San Francisco	Douglas fir, green, untreated	.82	1.14
	Douglas fir, empty cell, creosoted	1.73	2.32
Montreal	Birch or maple, untreated	.75@1.25	.75@1.25
	Birch or maple, creosoted	1.20@1.30	1.50@1.60

Current Prices of Construction Materials

Railway Supplies—Continued

TRACK SUPPLIES—Manufacturers' and dealers' quotations per 100 lb., f.o.b., Pittsburgh mill, for large mill lots, together with warehouse prices at other places named:

	Pittsburgh	Chicago	Birmingham	St. Louis	San Francisco
Standard spikes, ⅝-in. and larger	$2.80	$3.55	$3.50	$3.65@$3.95	$3.85
Track bolts	3.80	4.55	4.50	4.80@ 4.95	4.85
Standard section angle bars, splice bars or fish plates	2.75	3.40	3.50	.....	.....

Tie plates: Price at Pittsburgh and Chicago mills, $2.15 per 100 lb.

Pipe

WROUGHT-STEEL PIPE—Discounts from manufacturers' and dealers' standard lists:

	1 to 3-In. Butt Weld		2½ to 6-In. Lap Weld	
	Black	Galvanized	Black	Galvanized
Chicago, warehouse, delivered	54%	41%	51%	38%
Cleveland, warehouse, delivered	55½%	43½%	53½%	40½%
New York, warehouse, delivered	50%	36%	45%	32%
Pittsburgh, large mill lots, f.o.b.	62%	50½%	59%	47½%
St. Louis, warehouse, delivered	49%	36%	46%	33%

CAST-IRON PIPE—Prices of U. S. Cast Iron Pipe & Foundry Co., per net ton, for bell and spigot pipe, Class B and heavier, f.o.b., on regular lots of pipe:

	4-In.	6-In. and Over
Birmingham mill	$41.00	$38.00
Burlington (N. J.) mill	41.00	38.00
Chicago	49.20	46.20
New York	43.60	40.60
Pittsburgh	49.50	46.50
St. Louis	46.60	43.60
San Francisco	51.00	48.00

Gas pipe and Class A, $3.00 per ton extra.

SEWER PIPE—Dealers' quotations, delivered, in cents per foot, for standard pipe; 6, 8 and 12-in. are single strength and 18, 24, 30 and 36-in. are double strength:

	6-In.	8-In.	12-In.	18-In.	24-In.	30-In.	36-In.
Atlanta	$0.20	$0.34	$0.75	.....	.....	.....	.....
Baltimore	.16	.30	.58	.....	$1.93	.....	$6.50
Birmingham	.25	.40	.65	$1.50	2.75	$3.90	5.83
Boston	.18	.29	.54	1.30	2.15	3.50	5.90
Chicago	.15	.28	.54	1.25	2.25	4.75	6.00
Cincinnati	.144	.224	.432	.80	1.44	2.304	4.8175
Cleveland	.18	.28	.54	1.30	2.34	4.68	7.18
Dallas	.256	.42	.794	1.70	3.00	.....	.....
Denver	.161	.23	.414	.816	1.44	.....	.....
Detroit	.18	.28	.6075	1.50	2.70	5.12	7.91
Kansas City	.15	.29	.52	.....	1.80	3.90	.....
Los Angeles	.21	.2825	.51	1.186	2.03	3.39	5.09
Minneapolis	.16	.25	.50	1.15	1.84	3.49	4.97
Montreal	.36	.53	.78	1.48	2.75	4.20	.....
New Orleans	.18	.30	.54	1.02	1.95	.....	.....
New York	.185	.29	.56	1.35	2.45	4.60	7.07
Philadelphia	.117	.182	.351	**1.05**	**1.89**	3.60	5.6375
Pittsburgh	.0945	.147	.2835	.85	1.53	3.024	4.8175
St. Louis	.1645	.26	.468	1.092	1.872	3.65	4.80
San Francisco	.21	.30	.54	1.26	2.16	3.60	.....
Seattle	.22	.30	.54	1.26	2.16	3.60	.....

CLAY DRAIN TILE—Dealers' quotations, delivered, per 1,000 lin.ft.:

Size, In.	New York	Birm'ham	St. Louis	Dallas	San Fran.	Seattle
4	$55.00	$56.00	$50.00	$63.00	$67.50	60.00
6	112.00	105.00	112.00	110.00	112.50	112.00

Miscellaneous

LINSEED OIL—Dealers' quotations on raw oil, f.o.b., in 1- to 4-bbl. lots, per lb.:

New York....**$0.111** Chicago....**$0.114** Minneapolis....**$0.119**

WHITE AND RED LEAD—Dealers' quotations per 100-lb. keg, base price, f.o.b., New York: White, dry or in oil, $13.75; Red, dry, $13.75; Red, in oil, $15.25.

CHEMICALS—Water, sewage treatment, road work, round lots in the New York market:

Sulphate of aluminum, iron free, in bags, per 100 lb.	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb.	6.50@ 6.60
Soda ash, 58%, in bags, per 100 lb.	1.32@ 1.35
Chlorine, cylinders, per lb.	.05@ .08
Bleaching powder, in drums, f.o.b. works, per 100 lb.	2.00@ 2.10
Calcium chloride, in drums, f.o.b. works, per ton	20.00

MANILA ROPE—The number of feet per pound for the various sizes is as follows: ⅜-in., 8-ft.; ½-in., 6-ft.; ⅝-in., 4½-ft.; 1-in., 3½-ft.; 1¼-in., 2-ft., 10-in.; 1½-in., 2-ft. 4-in. Following are dealers' quotations per pound for ¾-in. and larger, delivered in 1,200-ft. coils:

Atlanta	$0.228	Kansas City	$0.29
Baltimore	.225	Los Angeles	.25
Birmingham	.26	Minneapolis	.24
Boston	.23	Montreal	.245
Chicago	.22	New Orleans	.25
Cincinnati	.21	New York	.21
Cleveland	.21	Philadelphia	.24
Dallas	.20	San Francisco	.205
Denver	.25	Seattle	.205
Detroit	.24	St. Louis	.215

BUILDING PAPER—Black, in carloads, per roll of 500 sq.ft., f.o.b., producing point **$1.97**

SLATERS FELT—In carloads, per roll, f.o.b., producing point **$0.80**

ROOFING MATERIALS—Dealers' quotations, f.o.b., New York, to contractors in carloads:

Asphalt felt, per 100 lb.	$2.60
Tar felt, per 100 lb.	2.60
Asphalt coating, per gal.	34½
Tar pitch, in 350 lb. barrels, per ton	28.00

PREPARED ROOFINGS—Dealers' quotations to contractors, in carloads, f.o.b. New York.

Single shingles, slate finish, sufficient to cover 100 sq.ft.	$0.12½
Strip shingles, 4 in 1, hexagonal shape, with Underwriters' label	3.00
Slate surfaced roofing in rolls weighing 85 to 90 lbs.	2.50

WINDOW GLASS—United inches 25, bracket size 6x8 to 10x15, single or double thickness, discount from jobbers' list (Sept. 15, 1928), at New York warehouses:

AA .....83% A .....86% B.....88%

EXPLOSIVES—Manufacturers' quotations per pound for dynamite delivered in small lots, under 200 lb.

	Gelatin 40%	Gelatin 60%		Gelatin 40%	Gelatin 60%
Atlanta	$0.22	$0.245	Los Angeles, f.o.b.†	$0.1875	$0.2225
Baltimore	.215	.2375	Minneapolis	.1925	.2125
Birmingham	.22	.245	Montreal	.195	.22
Boston	.225	.25	New Orleans	.195	.22
Chicago	.195*	.22*	New York	.255‡	.2775‡
Cincinnati	.22	.245	Philadelphia	.215	.24
Dallas	**.1875**	.21½	St. Louis	.215	.235
Denver, f.o.b.	.19	.2125	San Francisco	.1625	.1925
Kansas City, Mo.	.2025	.2225	Seattle	.16	.185

*Quantities above 500 lb. but less than a ton. †San Fernando Arsenal. ‡Special gelatin in case lots.

Lumber

Prices Are Per Thousand Feet, Board Measure

New York—Timbers, No. 1 common, rough, delivered to contractor at site of job, in 20 ft. lengths and under, per M. ft., b.m.:

	Long-leaf Yellow Pine	Douglas Fir
3x4 to 8x8	$57.00	$43.00
3x10 to 10x10	65.00	43.00
3x12 to 12x12	75.00	46.00
3x14 to 14x14	87.50	50.00

Chicago—Dealers' quotations, f.o.b., in carloads, No. 1 Common, rough, per M. ft. b.m. For delivery to job from stock, in truckloads, add $10 per M. ft.:

	20 Ft. and Under Long-Leaf Yellow Pine	Up to 32 Ft. Douglas Fir
3x4 to 8x8	$43.00	$42.00
3x10 to 10x10	50.50	42.00
3x12 to 12x12	62.50	42.00
3x14 to 14x14	74.50	43.00

San Francisco—Dealers' quotations on rough Douglas fir, No. 1 common, at yards. For delivery to contractor at site of job, add $1.50 to $5 per M. ft.:

	10-16-18 and 20 Ft.	22 and 24 Ft.
3x3 and 4	$28.00	$29.00
3x6 and 8	28.00	29.00
3x10 and 12	28.00	29.00
3x14	31.00	33.00

Other Cities—Dealers' quotations, delivered, No. 1 Common, rough, per M. ft:

	8x8-In. x 20 Ft. and Under				3x12 to 12x12-In. 20 Ft. and Under	
	Pine*	Fir†	Hemlock	Spruce	Pine*	Fir†
Atlanta	$47.50	.....	.....	.....	$67.50	.....
Baltimore	36.00	$50.25	$54.00	$61.00	75.00	$50.25
Birmingham	45.00	.....	.....	.....	60.00	.....
Boston	48.00	47.00	47.25	47.50	57.00	**52.00**
Cincinnati	52.50	62.50	.....	.....	70.00	57.50
Cleveland	65.00	65.00	.....	.....	65.00	65.00
Dallas	65.00	**57.50**	57.50	55.00	65.00	**57.50**
Denver	.....	57.00	57.00	55.00	.....	55@58
Detroit	62.50	51.50	.....	.....	68.50	51.50
Kansas City, Mo.	42.80	39.75	.....	.....	57.50	39.75
Los Angeles	.....	44.00	.....	.....	.....	**44.00**
Minneapolis	58.00	53.25	38.25‡	.....	58@60	53.25@54.75
Montreal	50.00	55.00	.....	.....	49.00	48.00
New Orleans	50.00	46.00	.....	44.00	67.00	63.00
Philadelphia	52.00	**44.00**	**44.00**	**50.00**	**62.00**	**43@45**
Pittsburgh	55@60	50@55	45@50	54@50	60@65	55@60
St. Louis	45.50	*39.00*	.....	.....	56.50	*39.50*
Seattle	.....	23.00	.....	.....	.....	**23.50**

	1x10 In. x 16 Ft. and Under			2x10 In. x 16 Ft. T. & Gr.	
	Pine*	Fir†	Hemlock	Pine*	Fir†
Atlanta	$60.00	.....	.....	$40.00	.....
Baltimore	56.00	$45.00	$45.00	.....	.....
Birmingham	36.00	.....	.....	43.00	.....
Boston	44.00	43.00	42.00	48.00	$47.50
Cincinnati	65.00	57.50	.....	42.00	55.00
Cleveland	60.00	55.00	.....	65.00	58.00
Dallas	60.00	.....	.....	.....	.....
Denver	.....	46.00	46.00	.....	50.00
Detroit	45.00	42.00	.....	*46.50*	**44.00**
Kansas City, Mo.	50.50	45.75	.....	44.75	36.75
Los Angeles	.....	*38.00*	.....	.....	57.00
Minneapolis	53.00	47.00	39.75‡	51.00	46.00
Montreal	56.00	48.00	40.00	85.00	70.00
New Orleans	43.00	40.00	.....	50.00	46.00
Philadelphia	*53.00*	**44.00**	**42.00**	**57.00**	**45.00**
Pittsburgh	55@60	50@55	45@50	55@60	50@65
St. Louis	*39.00*	**41.00**	*38.00*	**39.00**	37.00
Seattle	.....	21.00	.....	.....	23.00

*Long-leaf yellow pine. †Douglas fir. ‡F.o.b.

PILES—Dealers' quotations per lineal foot, pine, with bark on, f.o.b., New York

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41